

An exciting hobby.... for everyone

everyday electronics

MAY 74

20p 40-

FREE!

INSIDE

24 PAGE

Dictionary of Electronic Terms

Australia 40c
New Zealand 45c
South Africa 40c
Malaysia \$1.80
Sweden Kr.3,50
Malta 22c5

the
simple
answer
is...
make our
**EGG
TIMER**



...easy to build

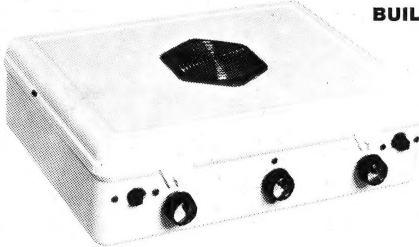
ELECTRONIC BAGPIPES



NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT.

BUILD THESE PROJECTS WITHOUT
SOLDERING IRON OR SOLDER.



Total Building Costs

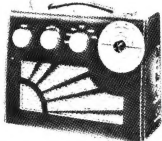
£7.23 P P & Ins. 44p.
(Overseas P & P £1.85p)
(+ 10% VAT 72p)

★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN-PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 6 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal Radio ★ One Transistor Radio ★ 2 Transistor Regenerative Radio ★ 3 Transistor Regenerative Radio ★ Audible Continuity Tester ★ Sensitive Pre-Amplifier.

★ 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 3 1/2 loudspeaker ★ Earpiece ★ Mica Baseboard ★ 3 12-way connectors ★ 2 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 3 Knobs ★ Ready Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6 3/4 yards of wire ★ 1 yard of sleeving, etc. ★ Parts price list and plans 50p (FREE with parts).

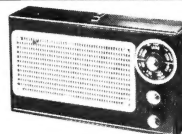
ROAMER TEN

with VHF including aircraft. 10 Transistors. Latest 4" x 2" watt Ferrite Magnet Loudspeakers. 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car Aerial and Tape Recording Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts). Total building costs P. P. & Ins. 52p (Overseas P. & P. £1.85) **£8.50** (+ 10% VAT 85p)



NEW EVERYDAY SERIES

Build this exciting New series of designs
E.V. 5 5 Transistors and 2 diodes. MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5 1/2" x 2 1/2" approx. Parts price list and Plans 15p. Free with parts. Total Building Costs **£2.73** P P & Ins. 30p (Overseas P & P £1.25p) (+ 10% VAT 27p)
E.V. 6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc. MW/LW coverage. Push Pull output. Parts price list and Plans 15p. Free with parts. Total Building Costs **£3.60** P P & Ins. 30p (Overseas P & P £1.25p) (+ 10% VAT 36p)
E.V. 7 Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" loudspeaker. Parts price list and easy build plans 20p. Free with parts. Total Building Costs **£4.08** P P & Ins. 31p (Overseas P & P £1.85) (+ 10% VAT 40p)



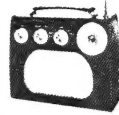
POCKET FIVE

3 Tunable wavebands. MW/LW. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5 1/2" x 1 1/2" x 3 1/2" approx. Plans and parts price list 15p. (Free with parts). Total Building Costs **£2.28** P P & Ins. 26p (Overseas P & P £1.25p) (+ 10% VAT 22p)



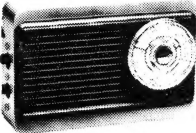
ROAMER EIGHT Mk 1 NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mw transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" x 2" watt Ferrite Magnet Loudspeakers. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9" x 7" x 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts). Total Building Costs **£6.98** P P & Ins. 47p (Overseas P. & P. £1.85) (+ 10% VAT 69p)



TRANSONA FIVE

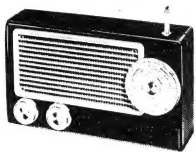
Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (Free with parts). Total Building Costs **£2.50** P P & Ins. 26p (Overseas P & P £1.25p) (+ 10% VAT 25p)



TRANS EIGHT

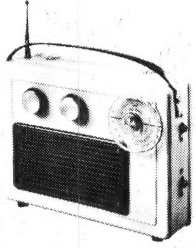
8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9" x 5 1/2" x 2 1/2in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts). Total Building Costs **£4.48** P P & Ins. 33p (Overseas P & P £1.25) (+ 10% V.A.T. 44p)



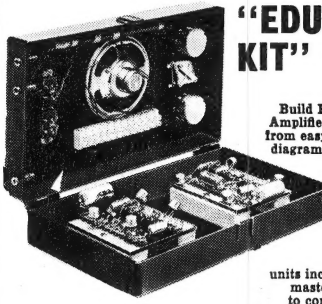
NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors. 9 Tunable wavebands as Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange control. Attractive all white case with red grille and carrying strap. Size 9 1/2" x 7" x 2 1/2" approx. Parts Price list and Plans 30p (FREE with parts) Total Building Costs **£6.95** P P & Ins. 44p. (Overseas P & P £1.85p) (+ 10% VAT 69p)

"EDU-KIT"



Build Radios, Amplifiers, etc. from easy stage diagrams. Five units including master unit to construct

Components include:
Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine 3" Tone Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three 1/2" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

Total Building Costs **£5.50** P P & Ins. 33p (Overseas P & P £1.85) (+ 10% VAT 55p)

ROAMER SIX

Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9" x 5 1/2" x 2 1/2in. approx. Plans and parts price list 25p (FREE with parts).

Total Building Costs **£3.98** P P & Ins. 31p (Overseas P. & P. £1.85) (+ 10% VAT 39p)

RADIO EXCHANGE CO

61a HIGH STREET, BEDFORD, MK40 1SA Tel. 0234 52367

Reg. no. 788372

I enclose £..... for.....

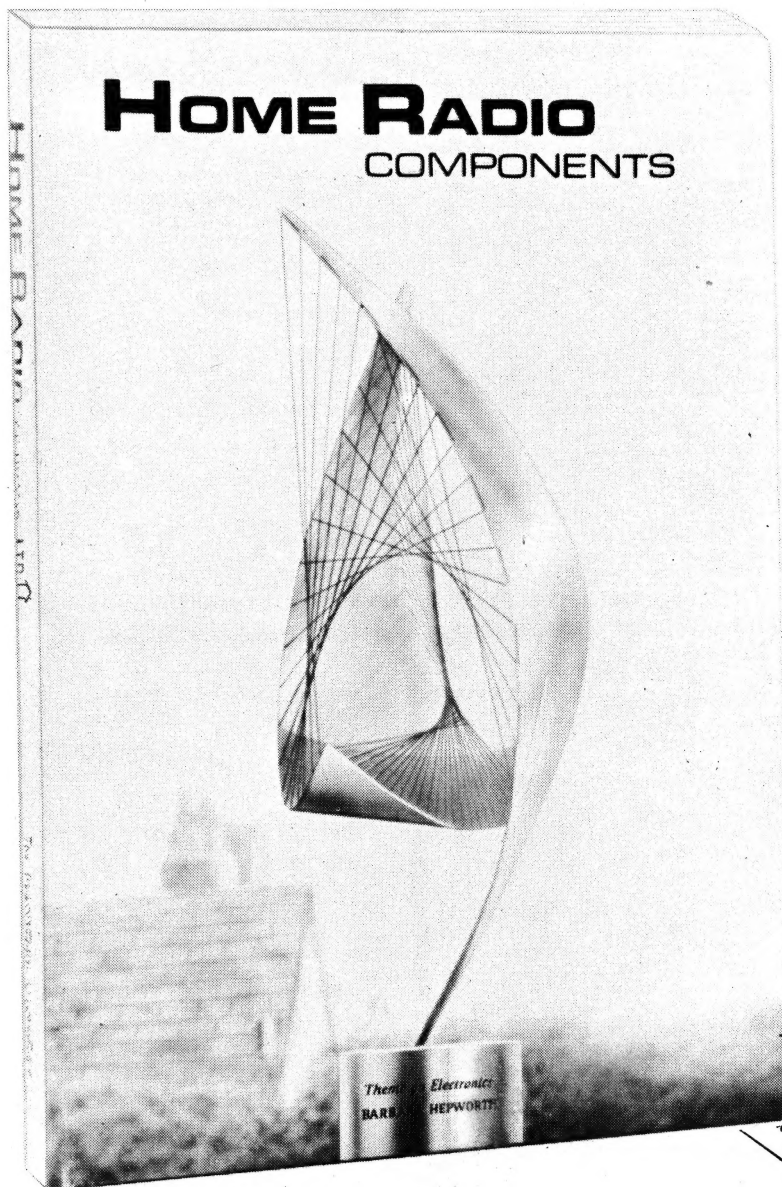
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6,785 electronic components clearly listed and indexed

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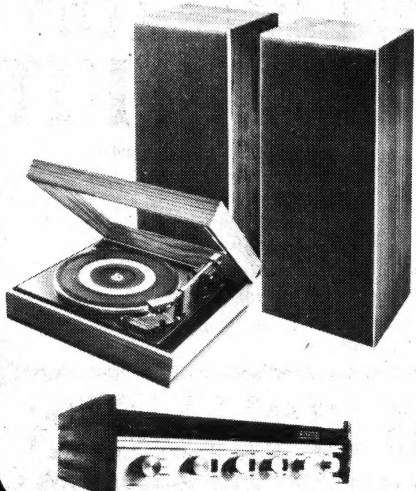
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Address _____

HOME RADIO (Components) LTD. (Regn. No. London 912966)
Dept. EE, 234-240 London Road, Mitcham CR4 3HD

R T V C

COMPLETE* STEREO SYSTEM



£51.00

40 Watt Amplifier.
Viscount III - R102 now 20 watts per channel. System I includes,
Viscount III amplifier - volume, bass, treble and balance controls, plus switches for mono/ stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0.1%. P.U.1 (for ceramic cartridges) 150mV into 3 Meg. P.U.2 (for magnetic cartridges) 4mV @ 1kHz into 47K, equalised within ± 1 dB R.I.A.A. Radio 150mV into 220K. (Sensitivities given at full power).
Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: ± 12 dB to -17 dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble ± 12 dB to -12 dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) -58 dB.
Crosstalk better than 35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. $13\frac{1}{2} \times 9 \times 3\frac{1}{2}$.
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers - Enclosure size approx. $17\frac{1}{2} \times 10\frac{1}{2} \times 6$ " in simulated teak. Drive unit 13×8 " with parasitic tweeter
Complete System £51.00

£69.00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers - Enclosure size approx. $31 \times 13 \times 17\frac{1}{2}$ ". Finished in teak veneer. Drive units approx. $13\frac{1}{2} \times 8\frac{1}{2}$ " with $3\frac{1}{2}$ " HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.
Complete System £69.00
PRICES: SYSTEM 1
Viscount III R 102 amplifier £24.20 + £1 p & p
2 Duo Type II speakers £14.00 + £2.20 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover £21.00 + £1.75 p & p.
total £59.20
Available complete for only £51.00 + £3.50 p & p.
PRICES: SYSTEM 2
Viscount R 102 amplifier £24.20 + £1 p & p
2 Duo Type IIIA speakers £39.00 + £4.00 p & p
Garrard SP25 with MAG. cartridge de luxe plinth £21.00 + £1.75 p & p. and hinged cover
total £84.20
Available complete for only £69.00 + £4 p & p.

STEREO 21



QUALITY SOUND* FOR LESS THAN £19.00

Stereo 21 easy to assemble audio system kit, - no soldering required. Includes:-
BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two 8" x 5" speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
For the technically minded:-
Specifications:
Input sensitivity 600mV/Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. $15\frac{1}{2} \times 8 \times 4$ ". Complete deck and cover in closed position approx. $15\frac{1}{2} \times 12 \times 6$ ". Complete only **£18.95 + £1.00 p & p**
Extras if required.
Optional Diamond Stylus **£1.37**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance, **£3.85.**



DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs.
*Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.
INPUT SENSITIVITIES
1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) - all 250mV sensitivity.
AC Mains 240V. operation.
Size approx. $12\frac{1}{2}$ ins x 6 ins x $3\frac{1}{2}$ ins
£13.50 + 60p.
postage & packing.



8 TRACK CARTRIDGE PLAYER*

Elegant self selector push button player for use with your own stereo system. Compatible with Viscount III system, the Stereo 21 and the Unisound module.
Technical specification.
Mains input, 240V. Output sensitivity 125mV
Comparable unit sold elsewhere at £24.00 approx.
Yours for only £10.95 + 90p. p & p



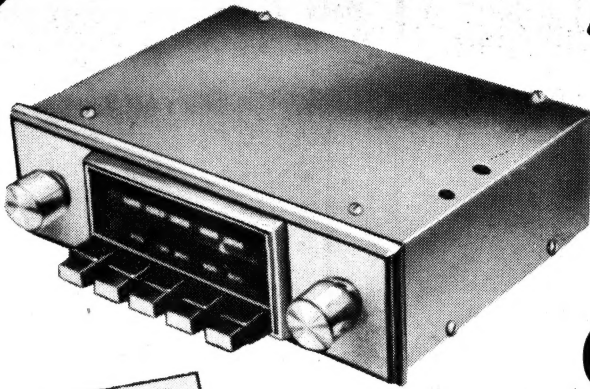
BUILD YOUR OWN STEREO AMPLIFIER*

For the man who wants to design his own stereo - here's your chance to start, with Unisound - pre-amp, power amplifier and control panel. No soldering - just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.
240V. AC only. **£7.64 + 55p. p & p**

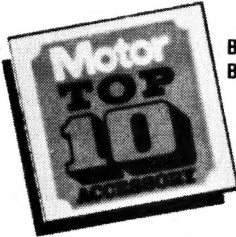
PETAPE LINK CONSTRUCTORS



A suitable 3 speed tape deck, less heads. Caters up to $5\frac{1}{2}$ ins. spools. 240V AC mains. Unused but store soiled hence no warranty: **£4.00 + £1.00 p & p**



Remember! one of the Top Ten Accessory Awards from Motor magazine **PUSH BUTTON*** **CAR RADIO KIT**



BUILD YOUR OWN TOURIST PUSH BUTTON CAR RADIO

Technical specification:

- 1.) Output 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
- 2.) Integrated circuit output stage, pre built three stage IF Module.

Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.

Size Chassis 7 ins. wide, 2 ins. high and 4 $\frac{5}{8}$ ins. deep approx.

NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p. free with kit.

Car Radio Kit

£6.60 + 55p. postage & packing.

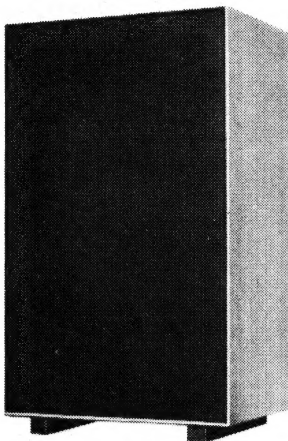
Speaker including baffle and fixing strips

£1.65 + 23p. postage & packing.

Recommended Car Aerial - fully retractable and locking.

£1.35 post paid.

THE ULTIMATE COMPLETE SPEAKER SYSTEM EMI LE 315



**Recommended retail
selling price, £86-00.**

**Our price £45-00 +
£3.50 postage & packing.**

A professional standard five way speaker system with enclosure giving top quality performance.

Enclosure Dimensions
approx. (3 ft. x 2 ft. x 1 ft.).

Drive Units

Hand built - 15" diameter bass with 3" voice coil,
- two 5" diameter Mid Range units,
- two 3 $\frac{1}{4}$ " HF. units,
plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.

Powder Handling

Continuous rating
35 W rms., Peak power
rating 70 W.

Frequency Response
20 Hz 20,000 Hz.
Impedance 8 ohms.

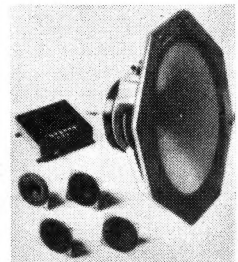
EMI SPEAKERS FANTASTIC REDUCTION



15" 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil.

**Recommended retail price
£40-80.**

**OUR PRICE £18-70 +
£1-50 p & p**



950 Kit - Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.

Huge 19" x 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.

The four 10,000 gauss tweeters, each 3 $\frac{1}{4}$ " dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2", others 0-5". Recommended list price £44-00.

**OUR PRICE £25-00 +
£1-50 p & p
Special Offer.**



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Everyday Electronics, May 1974

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7" x 4" LOUDSPEAKER

A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in. x 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: £1.00. Free postage on this item.

CRESCENT P.300. DISCO CONTROL PACK.

A control unit which when connected to twin decks makes a disco of professional quality. We supply a smart front panel which incorporates controls, switch and input sockets. The control module, I.C. construction, incorporating, mixing, pre-amp and head-phone listening amplifier. The power pack enables this unit to work from the standard mains. * Inputs include Mic. Tape/Cassette and Twin Decks. * Controls include Mic. Tape, Each Deck and P.E.L. Full instructions are included with every Pack. MONO = £14 plus 20p P.P. STEREO = £17 plus 20p P.P. Send a S.A.E. for more information.

STEREO / MONO HEADPHONE VOLUME CONTROL BOX

Plug Stereo phones into this control box and you then incorporate a right and left hand volume control and a stereo/mono switch. Complete with stereo jack plug and 2 m cable.

A Bargain at £1. Plus 10p P. & P.

LOW VOLTAGE AMPLIFIER

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.

With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.



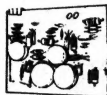
BARGAIN BOARDS

Components galore for the experimenter

Ex computer boards with:

Resistors, Capacitors and useful Transistors—at least 4 transistors per board.

5 BOARDS £1.00, P. & P. Free



TRI-VOLT BATTERY ELIMINATOR



Enables you to work your transistor radio, amplifier, or cassette, etc. from A.C. mains through this compact eliminator. Just by moving a plug you can select the voltage you require—6v, 7.5v or 9 volts. This means all your transistor power pack applications can be handled by this one unit. Approx. size: 2 1/4" x 2 1/4" x 3 1/4". OUR PRICE—£2.75p + 10p. P. & P. Same model suitably wired for the Philips Cassette—£3.00 + 10p. P. & P.

"CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U. BUILD. IT

We supply the three modules for you to build this Disco Group-P.A. amplifier into the cabinet of your choice.

★ THE POWER AMP MODULE TP 100W

170W. r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). £14.28, carr. 45p.

★ THE PRE-AMP MODULE

Four control pre-amp, Vol. Bass, Treble, Middle controls. Designed to drive most amplifiers using F.E.T. first stage. £3.96 carr. 25p.

★ THE POWER SUPPLY MODULE P8100

Is supplied complete with the mains transformer. £9.96, carr. 50p. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. If you purchase all three modules. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers

TRI-VOLT CAR CONVERTER

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or negative. This converter supplies 6, 7.5 or 9 volts and is transistor regulated. Approx. size 2 1/4" x 3 1/4" x 2" Very easy to fit and a real money saving device for £2.50 + 10p. P. & P.

WAFER SWITCHES

1 pole 12 way
2 pole 3 way
2 pole 4 way
2 pole 5 way
3 pole 4 way
18p each. Please inc. 5p P. & P. Up to 3 switches.



POTENTIOMETERS

All types 1" and less diameter. SINGLES DUAL
5K Log or 5K
10K Lin Less 10K
25K Switch 25K
50K Switch 50K
100K 12pea, 100K
250K Double 250K
500K Pole 500K
1M Switch 1M
2M 24pea, 2M

Up to 3 Pots. Please add 5p. P. & P.



MINIATURE RELAYS

Brand new range of British made Relays. Size—1 1/4" x 1" x 1/2"
All two changeovers with 250V. 1.5A contacts and suitable for fitting on 1m Veroboard.
Type Volts Current Ohms.
27/A 12v 17M/A 700 Ω
21/A 12v 28M/A 450 Ω
12/A 6v 33M/A 185 Ω
80p each.
Please include 5p P & P up to 3 Relays.

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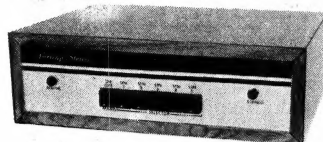
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EEB 54.
BLOCK CAPS please

YOU AIN'T HEARD NOTHIN' YET !!

... until you tune in to stereo perfection with the 'varicap'



Approx. Size 8 1/2" x 2 1/4" x 6 1/2"

Features include push button "Spot On" tuning, with up to 5 pre-set stations (no difficult tuning dial and drive cord). Easy "no problem" construction, requiring only a few simple setting up adjustments with a D.C. Voltmeter. Uses NEW pre-set modules for R.F. and I.F. circuits—no circuit alignment. High efficiency Integrated Circuit Phase Lock Loop Decoder for perfect stereo reception, with stereo lamp indicator. TOTAL KIT price only £28.50 including V.A.T. and postage. With Fibre Glass P.C. Board, neat slimline teak veneered cabinet with brushed aluminium front panels, push buttons etc. All parts available separately.

IDEAL FOR USE WITH THE "TEXAN", "GEMINI" AND ANY GOOD QUALITY STEREO AMPLIFIER. Please send large S.A.E. for full details.

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COMPLETE TELEPHONES

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TELEPHONE DIALS

Standard Post Office type. Guaranteed in working order

Only **27 1/2p** POST & PACKING 16p

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B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic	55p
B81	10	Reed Switches, 1" long, 1/8" dia. High Speed P.O. type	55p
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H4	250	Mixed Resistors. Approx. quantity, counted by weight	55p P & P 15p
H35	100	Mixed Diodes, Germ. Gold bonded, etc. Marked and Unmarked.	55p
H38	30	Short lead Transistors, NPN Silicon Planar types	55p
H39	6	Integrated Circuits, 4 Gates BMC 962, 2 Flip Flops BMC 945	55p
H41	2	Sil Power Transistors comp pair BD131/132	55p



Unmarked Untested Paks

B1	50	Germanium Transistors PNP, AF and RF	55p
B86	150	Germanium Diodes Min. glass type	55p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	55p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	55p
H16	15	Experimenters' Pak of Integrated Circuits, Data supplied	55p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp plastic. Mixed volts.	55p
H34	15	Power Transistors, PNP, Germ. NPN Silicon TO-3 Can.	55p

Make a rev counter for your car

The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car with normal coil ignition system.

£1-10p each

Ex GPO Push Button Intercom Telephones

Exactly as internal telephone systems still in everyday use where automatic internal exchanges have not yet taken over. Available in 5, 10 or 15 ways. Complete with circuits and instructions. Necessary 24 pair cable 22p per yard. Price of each instrument is independent of the number of ways.

£2.75

p.p. 38 1/2p

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Cable can be sent by Parcel Post. Post and Packing per 50 yds. 73p.

Extension Telephones. 71p each. p.p. 27 1/2p. £1 37 1/2 for 2. P & P. 55p.

These phones are extensions and do not contain bells.

A Cross Hatch Generator £3-85 post paid

A complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. A project in the Sept. '72 edition of Television. Subject to Availability

New Paks

TESTED & GUARANTEED

H63	4	2N3055 type NPN Sil. power transistors. Below spec. devices	55p
H64	4	3819 N Channel FETs	55p
H65	4	2N3819 in plastic case	55p
H65	4	40361 Type NPN Sil. transistors	55p
H66	4	TO-5 can comp to H65	55p
H66	4	40362 Type PNP Sil. transistors	55p
H66	4	TO-5 can comp to H65	55p

UNTESTED UNMARKED

H67	10	3819N Channel FETs plastic case type	55p
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Over 1,000,000 Transistors in stock

We hold a very large range of fully marked tested and guaranteed transistors, power transistors, diodes and rectifiers at very competitive prices. Please send for free catalogue.

Our very popular, 4p transistors

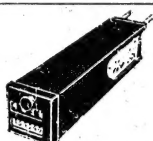
TYPE "A" PNP Silicon alloy, TO-5 can
TYPE "B" PNP Silicon, plastic encapsulation
TYPE "E" PNP Germanium AF or RF
TYPE "G" NPN Silicon plastic encapsulation
TYPE "H" NPN silicon similar ZTX 300 range
TYPE "H" PNP silicon similar ZTX 500 range

8 RELAYS FOR VARIOUS TYPES P & P 27 1/2p

£1-10p

High Speed Magnetic Counter

4 digit (non-reset)
24v or 48v (state which) 4 x 1 x 1in, 33p, p.p. 5p.



Plastic Power Transistors



NOW IN TWO RANGES

These are 40W and 90W Silicon Plastic Power Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

Range 1. VCE. Min 15. HFE Min 15.

	1-12	13-25	26-50
40 Watt	22p	20p	18p
90 Watt	26p	24p	22p

Range 2. VCE. Min. 40. HFE Min 40

	1-12	13-25	26-50
40 Watt	33p	31p	29p
90 Watt	38p	36p	33p

Complementary pairs matched for gain at 3 amps, 11p extra per pair. Please state NPN or PNP on order.

LM380 Audio I.C. as featured in Practical Wireless December issue complete with application data £1-10

INTEGRATED CIRCUITS

We stock a large range of I.C.s at very competitive prices (from 11p each). These are all listed in our FREE Catalogue, see coupon below.

METRICATION CHARTS now available

This fantastically detailed conversion calculator carries thousands of classified references between metric and British (and U.S.A.) measurements of length, area, volume, liquid measure, weights etc.

Pocket Size 15p Wall Chart 18p

LOW COST DUEL IN LINE I.C. SOCKETS

14 pin type at 16p each } Now new low profile
16 pin type at 18p each } type

BOOKS

We have a large selection of Reference and Technical Books in stock.

Send for lists of publications

Our famous P1 Pak is still leading in value

Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN, and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

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Please ask for Pak P.1. only **55p**

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SPECIAL RESISTOR KITS (Prices include post & packing)

10E12 1W KIT:	10 of each E12 value, 22 ohms—1M, a total of 570	CARBON FILM 5%,	£3.65	net
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10E12 2W KIT:	10 of each E12 value, 10 ohms—1M, a total of 610	METAL FILM 5%,	£17.15	net



AUDIOTRONIC Model ATM1

Top value 1,000
opv pocket multi-
meter. Ranges: -
0/10/50/250/1,000
volt AC and DC.
DC current 0-1mA/
100mA. Resistance:
0/150k ohms.
Decibels: -10 to
+22dB. Size 90 x
60 x 28mm.
Complete with
test leads.

OUR PRICE £2.95

P&P 15p



AUDIOTRONIC Model ATM5

Jewel movement,
attractively moulded
case with edgewise
ohms adjustment.
Ranges: 0-3/15/150/
300/1200V AC.
2500 opv. 0-5/30/
300/600V DC.
(5000 opv). 0-300
uA/0-300mA DC.
Resistance: x 10 &
x 100. -10 to +16dB.
Supplied with battery
test leads and data
booklet. Size: 121 x 73 x 29mm.

OUR PRICE £3.50

P&P 15p

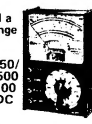


MODEL C1092 MULTIMETER

Features 5,092 opv
jewel movement and a
good selection of range
functions. Edgewise
ohms adjustment.
Ranges: 0-3/15/150/
300/1,200V AC (2,500
opv). 0-6/30/300/600
V DC (5,000 opv).
DC current: 0-300uA/
300mA. Resistance:
R x 10, R x 1,000. -10 to +16dB.
Complete with battery,
test leads and data
booklet. Size: 120 x 73 x 28mm.

OUR PRICE £3.75

P&P 35p



MODEL U437 MULTIMETER

10,000 opv. A first
class, instrument
manufactured in
USSR to the highest
standards. Ranges:
2.5/10/50/250/
500/1000V DC.
2.5/10/50/250/
500/1000V AC.
DC current 100uA/
1/10/100mA/1A.
Resistance 300 ohms/
300/300k/3 Meg.
ohms. Complete with batteries, test
leads, instructions and a sturdy steel
carrying case.

OUR PRICE £4.95

P&P 25p



MODEL TH12

20,000 opv. Overload
protection. Slide switch
selector. 0/0.25/2.5/10/
50/150/1000V DC. 0/10/
50/250/1000V AC. 0/
50uA/25/250mA DC.
0/30k/300k/3 Megohms. -20 to
+50dB.

OUR PRICE £5.95

P&P 15p



HIKI Model 720X VOM

A versatile,
accurate measuring
instrument. 20,000 opv. 0/
5/25/100/500/
1000V DC. 0/10/
50/250/1000V AC. 0-50uA/
250mA. 0-20k/
2 Megohms.

OUR PRICE £5.97

P&P 20p



MODEL PL436

20,000 opv DC.
8000 opv AC.
Mirror scale.
Ranges: 6/12/30/120/
600V DC. 3/30/
120/600V AC. 60/
600uA/60/
600mA.
10/100k/1 Meg/10 Meg Ohm.
-20 to 46dB.

OUR PRICE £6.97

P&P 15p



U4323 MULTIMETER

20,000 opv. Simple
unit with audio/IF
oscillator. Suitable
for general receiver
tuning. Ranges:
0.5/2.5/10/50/250/
500/1000V DC.
2.5/10/15/250/500/1000V AC. 0.05/
0.5/5/50/500mA DC. Resistance: 5/
50/500 ohms/5/10/100k ohms/1 Meg.
Battery operated. Size: 160 x 97 x
40mm. Supplied in carrying case complete
with test leads.

OUR PRICE £7.00

P&P 20p



MODEL HIOKI 730X

30,000 opv. Overload
protection. 6/30/60/300/600/
1200V DC. 12/60/
120/600/1200V AC.
60 uA/
30mA/300mA.
2K/200 Ohm.
2 Meg Ohm.
10 to 63dB.

OUR PRICE £7.50

P&P 15p



MODEL TE300

30,000 opv. Mirror
scale. Overload
protection. 0/0.6/3/15/
60/300/1200V DC.
0/6/30/120/600/
1200V AC. 0/30uA/
60mA/300mA/300mA.
60mA. 0/8k/80k/
800k/8 Meg ohms.
-20 to +63dB.

OUR PRICE £7.50

P&P 15p



U4324 MULTIMETER

High sensitivity, over-
load protection. Ranges:
20,000 opv. 0.6/1.2/3/12/30/
60/120/600/1200V
DC. 3/6/15/60/150/
300/600/900V AC.
Current: 0.06/0.6/
6/60/600mA/3A DC.
0.3/3/30/300mA/
3A AC. Resistance:
25/500 ohms/0.5/5/50/500k ohms/5
Megohms. Decibels: -10 to +12dB. Size
167 x 98 x 63mm. Supplied complete
with test leads, spare diode and
instructions.

OUR PRICE £8.00

P&P 20p



TMK MODEL TW50K

46 ranges, mirror
scale. 50kV DC.
50kV AC.
DC Volts: 0.125/
0.25/1.25/2.5/5/10/
25/50/125/250/
500/1000. AC Volts
1.5/5/10/25/50/
125/250/500/
1000. DC current
25/50uA/2.5/5/25/
50/250/500mA/5/
10A. Resistance:
10k/100k/1 Meg/
10 Meg ohms. -20 to +81.5dB.

OUR PRICE £8.50

P&P 17p



U435 MULTIMETER

20,000 opv. Overload
protection. Ranges:
75mV/2.5/10/25/
100/250/500/1000V
DC. 2.5/10/25/100/
250/500/1000V AC.
Current: 50uA/1/5/
25/100mA/0.5/2.5A
DC. 5/25/100mA/
0.5/2.5A AC. Resistance:
0.3/3/30/300k
ohms. Size: 205 x 110 x 84mm. Supplied
complete with leads, crocodile
clips and carrying case.

OUR PRICE £8.75

P&P 20p



U91 Clamp VOLT AMMETER

For measuring AC volt-
age and current without
breaking circuit. Ranges:
300/600V AC. Current:
10/25/100/250/500A.
Accuracy 4%. Size 263 x
94 x 36mm. Complete
with carrying case, leads
and fuses.

OUR PRICE £10.50

P&P 20p



U4312 MULTIMETER

extremely sturdy
instrument for
general electrical
use. 667 opv.
0/0.3/1.5/7.5/30/
60/150/300/600/
900V DC & 75mV.
0/0.3/1.5/7.5/30/
60/150/300/600/
900V AC. 0/300uA/
1.5/6/15/150/60/
600mA DC. 0/1.5/15/
60/150/600mA/
1.5/6A AC. 0/200/3k/30k ohms. DC
accuracy 1%. AC 1.5%. Knife edge
pointer, mirror scale. Complete with
sturdy metal carrying case, leads and
instructions.

OUR PRICE £9.75

P&P 25p



MODEL 500

30,000 opv with
overload protection.
Mirror scale. 0/0.5/2.5/10/25/
100/250/500/
1000V DC. 0.5/2.5/10/25/50/100/
250/500/1000V AC. 0.5/50uA/5/50/
500mA. 12A DC.
0/60k/6 meg/60 megohms.

OUR PRICE £13.95

Carr. paid

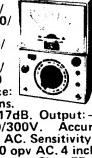


HIOKI 750X VOLT-OHM-MILLIAMMETER

43 ranges: 0-0.3/0.6/
1.5/3/6/12/30/60/150/
300/600/1,200V DC.
0-3/6/15/30/60/120/
300/600/1,200V AC.
0-30/60uA/
1.5/3/15/30/150/300
mA/12A. Resistance:
0-3/30k/300k ohms.
Decibels: -10 to +17dB. Output:
-0.3/6/15/30/60/120/300V. Accuracy:
3% DC. 4% AC. Sensitivity:
50,000 opv DC. 5,000 opv AC. 4 inch
meter. Built in protection. Size: 57 x
102 x 153mm.

OUR PRICE £11.95

P&P 40p



HIOKI MODEL 700X

100,000 opv. Overload
protection. Mirror scale.
0.3/0.6/1.2/1.5/3/6/
12/30/60/120/300/
600/1200V DC.
1.5/3/6/12/30/60/150/
300/600/1200V AC.
15/30uA/3/30/60/
150/300mA/12A DC.
2k/200k/2M/20M Ohms.
-20 to +63dB.

OUR PRICE £14.95

P&P 20p

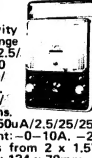


Model HT100B4 MULTIMETER

Overload protected,
shock proof circuits.
9.5uA meter with
mirror scale. Sensitivity
100kV polarity change
switch. Ranges: 0.5/2.5/
1.5/50/250/1,000
Volts DC. 2.5/10/50/
250/1,000 Volts AC.
DC resistance: 0-20/
200k/2/20 Meg. ohms.
DC current: -10/250uA/2.5/25/250
mA/10A. AC current: 0-10A. -20
to +62dB. Operates from 2 x 1.5V
batteries. Size: 180 x 134 x 79mm.

OUR PRICE £15.00

P&P 40p



MODEL AS.100D VOM

100,000 opv.
Mirror scale.
Built-in meter
protection. 0/3/
12/60/120/300/
600/1200V DC.
0/6/30/120/300/
600V AC. 0/10uA/
6/60/300mA/
12 Amp. 0/2k/
200k/2M/200 Meg
Ohm. -20 to 17dB.

OUR PRICE £17.50

P&P 20p



KAMODEN HM720B FET VOM

Input impedance 10
Megohms. Ranges:
0.25/2.5/10/25/100/
1000V DC. 0.2/5/10/
50/250/1000V AC.
0/25uA/2.5/25/250
mA DC.
0/5k/50k/500k/5M
500 Megohms.

OUR PRICE £21.00

P&P 30p



KAMODEN 72.200 Multimeter

High sensitivity
tester. 200,000 opv.
Overload protected.
Mirror scale.
Ranges: 0/0.6/3/
3/30/120/600/
1200V DC. 0/3/
12/60/300/1200
V AC. 0/6uA/
1.2mA/120mA/
600mA/12A DC.
0/12A AC. -20 to
+63dB. 0/2k/200k/
2 Meg/200 Megohms.

OUR PRICE £22.50

P&P 30p

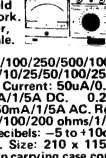


U4317 MULTIMETER

High sensitivity
instrument for field
and laboratory work.
Knife edge pointer,
86mm. mirror scale.
Ranges: 100mV/
0.5/2.5/10/25/50/100/250/
500/1000V DC. 0.5/2.5/10/25/50/100/250/
500/1000V AC. Current: 50uA/0.5/
1/5/10/50/250mA/1.5A DC. 0.25/
0.5/1.5/10/50/250mA/1.5A AC. Resistance:
0.5/10/100/200 ohms/1/3/
30/300k ohms. Decibels: -5 to +10dB.
Battery operated. Size: 210 x 115 x
90mm. Supplied in carrying case complete
with leads.

OUR PRICE £15.00

P&P 20p



TMK 100k LAB TESTER

100,000 opv. 6V
scale. Buzzer.
short circuit check.
Sensitivity 100,000
opv DC. 5kV AC.
DC Volts: 0.5/2.5/
10/50/250/1000V
AC. 3/10/50/250/
500/1000V DC.
current: 10/100/
100/500mA/2.5/10A. Resistance:
1k/10k/100k/10 Meg/100 Meg ohms.
Decibels: -10 to +49dB. Plastic case
with carrying handle. Size: 190 x 172
x 99mm.

OUR PRICE £19.95

P&P 25p



MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330
Ohms/Volt AC
and DC.
Accuracy 0.5%
DC. 1% AC.
Range length:
165mm.
0/300/750uA/
1.5/3/7.5/15/
30/75/150/300/750mA/1.5/3/
7.5A DC. 0/3/
7.5/15/30/75/
150/300/750mA/
1.5/3/7.5A AC.
0/75/150/300/750mV/1.5/3/7.5/15/
30/75/150/300/750V DC. 0/750mV/
1.5/3/7.5/15/30/75/150/300/750
V AC. Automatic cut out device. Supplied
complete with test leads, manual
and test certificates.

OUR PRICE £49.00

P&P 50p



TE40 HIGH SENSITIVITY AC VOLT METER

10 Meg input.
10 ranges: 0.001/
0.03/0.1/0.3/
1/3/1/30/100/
300V RMS.
Scps: 1-2MHz.
-40 to +50dB
supplied complete
with leads and
instructions.

OUR PRICE £17.50

P&P 25p



TE65 VALVE VOLTMETER

28 range DC volts
1.5-1500V AC.
volts 1.5-1500V.
Resistance up to
1000 Megohms.
200/240V AC
operation. Complete
with probe and
instructions.

OUR PRICE £17.50

P&P 30p



LB3 TRANSISTOR TESTER

Tests IC and B.
PNP/NPN. Operates
from 9V battery.
Instructions supplied.

OUR PRICE £3.95

P&P 20p



MODEL AF.105 VOM
60,000 opv. Mirror
scale. Meter
protection.
0/3/3/12/60/120/
300/600/1200V DC.
0/6/30/120/
300/600/1200V AC.
0/30uA/6/
60/300mA/
12 Amp. 0/10k/
1m/10m/100
Meg Ohms. -20 to 17dB.
OUR PRICE £12.50 P&P 20p.



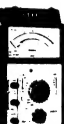
LB4 TRANSISTOR TESTER

Tests PNP or NPN
transistors. Audio
indication. Operates
on two 1.5V
batteries. Complete
with instructions etc.
OUR PRICE £4.50 P&P 20p



U4341 Multimeter & Transistor Tester

27 ranges, 16,700 opv.
Overload protected.
Ranges: 0.1/1.5/5/
30/60/150/300/900V
DC. 1.5/7.5/30/150/
300/500V AC.
Current: 0.06/0.6/
6/60/600mA DC.
0.3/3/30/300mA AC.
0.6/2.5/20/60/200k ohms/2 Megohms.
Battery operated. Supplied complete
with probes, leads and steel carrying
case. Size: 115 x 15 x 90mm.
OUR PRICE £10.50 P&P 20p



KAMODEN HMG500 insulation resistance tester

Range 0-1
1000V DC. 500V.
Battery operated.
Wide range clear
meter 4" x 4".
Complete with
deluxe carrying case,
batteries and instructions.
OUR PRICE £19.95 P&P 30p



S100TR MULTIMETER TRANSISTOR TESTER

100,000 opv. Mirror
scale. Overload
protection. 0/0.12/
0.6/3/12/30/120/
600V DC. 0/6/30/
120/600V AC.
10/100/1000V DC.
0/100/1000V AC.
100 Meg.
-20 to +50dB.
0.01-0.2MFD
Transistor tester. Measures Alpha, Beta
and ICO. Complete with instructions,
batteries and leads.

OUR PRICE £15.95

P&P 25p



C15 PULSE OSCILLOSCOPE

For display of pul



Also see previous page

SWR Meter Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedance 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.



OUR PRICE £4.25

P&P 25p

AT201 Decade ATTENUATOR

Frequency range 0-200kHz. Attenuator 0-111dB, 0.1dB steps. Impedance 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.



OUR PRICE £12.50

P&P 37p

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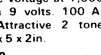
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5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.



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Six bands, 120kHz-260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements: 105-125V, 220-240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.



OUR PRICE £17.50

P&P 40p

TE-200 RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R.F. attenuator audio output. Xtal socket for calibration. 220/240V a.c. Brand new with instructions. Size 140mm x 215mm x 170mm.



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All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100kHz. Output Square/Sine wave 10V. P.P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.



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MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000Hz Sine Wave. Output Sine or Square wave 10V. P to P. Size 180 x 90 x 90mm. Operation 220/240V. A.C. OUR PRICE £19.95



P&P 37p

MC4220 Automatic Voltage Stabiliser

Input 88-125V AC or 176-250V AC. Output 120V AC or 240V AC. 200V/A rating. P&P 50p



OUR PRICE £11.97

PS100B Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor voltage and current. Input 220/240V AC. Size: 100 x 82 x 159mm.



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Solid state. Variable output 5-20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.



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Excellent quality at low cost. Input: 230V 50/60Hz. Output 0-260V. Model S260 BENCH MOUNTING

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2.5A £12.00 30p

5A £17.50 37p

8A £30.35 50p

10A £33.75 75p

12A £29.50 75p

20A £85.00 125p

25A £95.00 130p

40A £120.00 150p

Model S260B PANEL MOUNTING

1A £10.00 30p

2.5A £12.00 35p

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MW 1-6 60x60mm

£6.50 P&P 15p

MW 1-8 80x80mm

£6.90 P&P 15p

40A £120.00 150p

Model S260B PANEL MOUNTING

1A £10.00 30p

2.5A £12.00 35p

5A £17.50 37p

8A £30.35 50p

10A £33.75 75p

12A £29.50 75p

20A £85.00 125p

25A £95.00 130p

40A £120.00 150p

Model S260B PANEL MOUNTING

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5A £17.50 37p

8A £30.35 50p

10A £33.75 75p

12A £29.50 75p

BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0-180 degrees. Blank scales 1-5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. Deep including knob and coupling. 1/4" diam. shaft



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WALKIE TALKIES

SKYFON 100mW OUR PRICE £24.95 per pair

P302 Two Channel 300mW OUR PRICE £52.50 per pair

P1003 Three Channel 1 Watt OUR PRICE £71.25 per pair

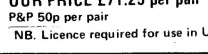
P&P 50p per pair

NB. Licence required for use in UK



RUH6 Reflex Horn Speaker

Built-in driver unit. Impedance 16 ohms. Power rating 10W. Response 380-7000Hz. Size: app. 6" x 6". Weather and shock protected.

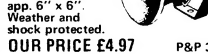


OUR PRICE £4.97

P&P 30p

TRIO 9A59DS RECEIVER

Four bands covering 550kHz to 30 MHz continuous and electrical band-spread on 10, 15, 20, 40 and 80 mtrs. 8 valve plus diode circuit. 4 to 8 ohm output and phone jack. SS5-CW, ANL, variable BFO, S Meter and separate band spread dial. IF frequency 455kHz, audio output 1Watt. Variable RF and AF gain controls. 115/250V AC, with instructions.



OUR PRICE £42.50

CARR. PAID

TRIO TR2200 TRANSCEIVER

Fullly transistorised portable VHF transceiver. Will transmit and receive on six channels between 144-146MHz. 1 watt transmit. 12V DC internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphone and 144.48, 144.72 & 145.32 crystals. Size: 134 x 58 x 180mm.

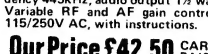


OUR PRICE £79.50

Carr. paid

BELTEK W5400 CAR TRANSCEIVER

Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel select. or. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145.32. 13,000Hz. 8 watts RMS. Available 8 or 15 ohms.



OUR PRICE £75.00

P&P 50p

DT55G DIGITAL CLOCK MECHANISM

Features 24 hour alarm setting, on/off and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240W AC operation. Switch rating 250V-3 Amp.

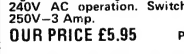


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P&P 30p

KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries



OUR PRICE £5.25

P&P 50p

LH02S STEREO HEADPHONES

Light weight head-phones with padded ear pieces. 4/16 ohms 20-20,000Hz. Complete with 6' lead and plug.



OUR PRICE £1.97

P&P 30p

TE1018 Deluxe Mono High Impedance Headset.

Sensitive magnetic headset with soft ear pads. Impedance 2,600 ohms (600 ohms DC). Frequency response: 200-4,000Hz.



OUR PRICE £2.25

P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedance 8 ohms. 20-12,000Hz. Complete with lead and plug.



OUR PRICE £2.50

P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedance. Frequency response 25Hz-18kHz. Complete with cable and stereo jack plug.



OUR PRICE £2.60

P&P 30p

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Volume control for each channel. 4/16 ohms impedance. Frequency response 20Hz-18kHz. Complete with 10ft. coiled lead and jack plug.



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P&P 30p

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Moving coil. Ideal for language teaching, communications etc. Headphone impedance 16 ohms. Microphone impedance 200 ohms.



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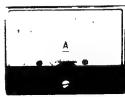
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CLEAR PLASTIC MODEL SD640

Size: 85 x 64mm

500A	£3.80		
100A	£3.75		
200A	£3.70		
500A	£3.65		
50-0-500A	£3.75		
100-0-1000A	£3.70		
1mA	£3.65		
5mA	£3.65		
10mA	£3.65		
50mA	£3.65		
100mA	£3.65	20V DC	£3.65
500mA	£3.65	50V DC	£3.65
1A DC	£3.65	300V DC	£3.65
5A DC	£3.65	15V AC	£3.75
10A DC	£3.65	300V AC	£3.75
5V DC	£3.65	VU Meter	£3.90



*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD830

Size: 110 x 83mm

500A	£4.30		
100A	£4.25		
200A	£4.20		
500A	£4.15		
50-0-500A	£4.25		
100-0-1000A	£4.20		
1mA	£4.10		
5mA	£4.10		
10mA	£4.10		
50mA	£4.10		
100mA	£4.10	10V DC	£4.10
500mA	£4.10	20V DC	£4.10
1A DC	£4.10	50V DC	£4.10
5A DC	£4.10	300V DC	£4.10
10A DC	£4.10	15V AC	£4.20
10A DC	£4.10	300V AC	£4.20
5V DC	£4.10	VU Meter	£4.40



CLEAR PLASTIC MODEL MR 65P

Size: 86 x 78mm

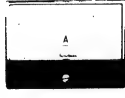
500A	£3.95		
100A	£3.85		
200A	£3.80		
500A	£3.75		
50-0-500A	£3.85		
100-0-1000A	£3.80		
500-0-5000A	£3.70		
5mA	£3.70		
10mA	£3.70		
50mA	£3.70		
100mA	£3.70		
500mA	£3.70	50V AC	£3.80
1A DC	£3.70	150V AC	£3.80
5A DC	£3.70	300V AC	£3.90
10A DC	£3.70	500V AC	£3.80
15A DC	£3.70	S Meter 1mA	£4.10
20A DC	£3.80	VU Meter	£3.70
30A DC	£3.85	1A AC	£3.70
50A DC	£4.05	5A AC	£3.70
5V DC	£3.70	10A AC	£3.70
10V DC	£3.70	20A AC	£3.70
20V DC	£3.70	30A AC	£3.70
30V DC	£3.70	50A AC	£3.70
150V DC	£3.70	100mA AC	£3.70
300V DC	£3.70	200mA AC	£3.70
15V AC	£3.80	500mA AC	£3.70



CLEAR PLASTIC MODEL SW100

Size: 100 x 80mm

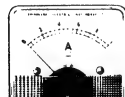
500A	£4.60		
100A	£4.50		
200A	£4.40		
500A	£4.30		
50-0-500A	£4.50		
100-0-1000A	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30		
50V DC	£4.30	300V AC	£4.45
300V DC	£4.30	VU Meter	£4.90



CLEAR PLASTIC MODEL MR 45P

Size: 50 x 50mm

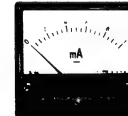
500A	£3.20		
100A	£3.15		
200A	£3.10		
500A	£3.00		
50-0-500A	£3.15		
100-0-1000A	£3.10		
500-0-5000A	£2.95		
1mA	£2.95		
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95	300V AC	£3.05
1A DC	£2.95	S Meter 1mA	£2.95
5A DC	£2.95	VU Meter	£3.40
10V DC	£2.95	1A AC	£2.95
20V DC	£2.95	5A AC	£2.95
50V DC	£2.95	10A AC	£2.95
300V DC	£2.95	20A AC	£2.95
15V AC	£3.05	30A AC	£2.95



BAKELITE MODEL S80 Enlarged Window

Size: 80 x 80mm

500A	£4.50		
100A	£4.45		
200A	£4.40		
500A	£4.35		
50-0-500A	£4.45		
100-0-1000A	£4.40		
1mA	£4.20		
1A DC	£4.20		
5A DC	£4.20		
20V DC	£4.20		
50V DC	£4.20		
300V DC	£4.20		
300V AC	£4.30		
VU Meter	£4.70		



EDGWARE MODEL PE70

Size: 90 x 34mm

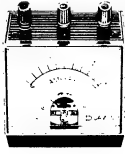
500A	£4.15		
100A	£4.10		
200A	£4.05		
500A	£3.90		
50-0-500A	£4.10		
100-0-1000A	£4.05		
1mA	£3.85		
300V AC	£3.95		
VU Meter	£4.30		



MODEL ED107 EDUCATIONAL METER

Size: 100 x 90 x 150mm including terminals

A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.

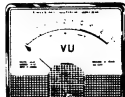


500A	£8.50		
100A	£7.90		
50-0-500A	£7.90		
1A DC	£7.90		
5A DC	£7.60		
5V DC	£7.60		
10V DC	£7.60	300V DC	£7.60
15V DC	£7.60	50V/50V DC	£7.60
20V DC	£7.60	5V/15V DC	£7.60
50V DC	£7.60	1A/15A DC	£7.60

CLEAR PLASTIC MODEL MR 85P

Size: 120 x 110mm

500A	£5.45		
100A	£5.40		
200A	£5.35		
500A	£5.25		
50-0-500A	£5.40		
100-0-1000A	£5.35		
500-0-5000A	£5.20		
1mA	£5.20		
1-0-1mA	£5.20		
5mA	£5.20		
10mA	£5.20		
50mA	£5.20		
100mA	£5.20		
500mA	£5.20	300V DC	£5.20
1A DC	£5.20	300V AC	£5.30
5A DC	£5.20	S Meter 1mA	£5.20
15A DC	£5.20	VU Meter	£5.55
30A DC	£5.20	5A AC	£5.20
10V DC	£5.20	10A AC	£5.20
20V DC	£5.20	20A AC	£5.20
50V DC	£5.20	30A AC	£5.20
150V DC	£5.20		



CLEAR PLASTIC MODEL SD460

Size: 59 x 46mm

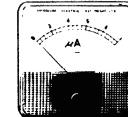
500A	£3.50		
100A	£3.45		
200A	£3.40		
500A	£3.35		
50-0-500A	£3.45		
100-0-1000A	£3.40		
1mA	£3.30		
5mA	£3.30		
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10A DC	£3.30		
5V DC	£3.30		
10V DC	£3.30		
50V DC	£3.30		
300V DC	£3.30		
15V AC	£3.45		
300V AC	£3.45		
VU Meter	£3.65		



CLEAR PLASTIC MODEL MR 52P

Size: 60 x 60mm

500A	£3.70		
100A	£3.65		
200A	£3.60		
500A	£3.55		
50-0-500A	£3.65		
100-0-1000A	£3.60		
1mA	£3.50		
5mA	£3.50		
10mA	£3.50		
50mA	£3.50		
100mA	£3.50		
500mA	£3.50		
1A DC	£3.50		
5A DC	£3.50		
20V DC	£3.50		
50V DC	£3.50		
300V DC	£3.50		
15V AC	£3.40		
300V AC	£3.40		
S Meter 1mA	£3.30		
VU Meter	£3.80		



BAKELITE MODEL MR 65

Size: 80 x 80mm

250A	£5.25		
500A	£4.00		
100A	£3.95		
500A	£3.65		
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5A DC	£3.60		
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10V DC	£3.60		
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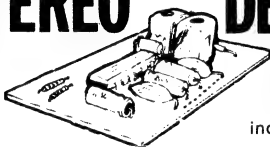


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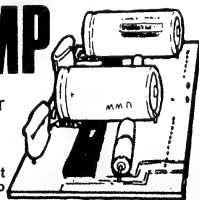
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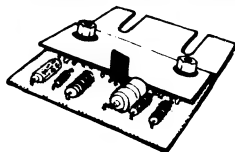
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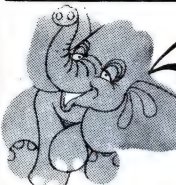
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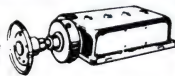
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PROJECTS..
THEORY.....

SOUNDS DIFFERENT

Now, for something quite different, as they say, in sound. We are all familiar with a host of unique sounds (musical or otherwise!) that electronics has been entirely responsible for. But in addition to creating original sounds, electronics is of course very good at imitating sounds, such as those characteristic of traditional musical instruments. Many examples have already appeared, but so far as we are aware the Bagpipes have not been singled out for this favoured treatment—until now.

We wonder why. Anyhow to demonstrate our strict neutrality in matters musical as well as geographical, we offer our readers this latest musical novelty. It is, incidentally, yet another example of the inspired use of fairly conventional circuitry. So please remember, all you would-be inventors, it is that original thought for applying electronics to some account in an unusual or novel way, that is all important; the actual circuitry comes quite naturally thereafter, in many cases.

SPEED GUARD

The tendency of motorists to travel at unsafe speeds when caught in fog has a perfectly reasonable explanation, so the experts tell us. It is really because sense of speed is seriously affected when sight of external reference points is lost due to poor visibility, the need to concentrate fully on the road ahead precluding any diversion of attention—even momentarily—

from windscreen to speedometer. So an unconscious steady acceleration is all too commonly the result.

In an attempt to overcome this particular problem we understand that the authorities are currently investigating a "head-up" display speedometer, where the appropriate data is projected onto the windscreen and is readable without interfering in any way with the driver's normal view.

It is to be hoped that success is the outcome of this attempt to produce a cheap and relatively simple version of the more sophisticated system already employed in aircraft, so that in time it could become standard equipment for all vehicles. In the meanwhile it occurs to us that the *Speed Guard* described in the March issue of *EVERYDAY ELECTRONICS* could very well be widely adopted as a fog hazard aid, providing an audible indication that some pre-determined speed (reasonably low—30 m.p.h. for example) has been reached. The addition of an on/off switch is all that would be necessary to make the *Speed Guard* suitable for this kind of function; it could then be easily brought into operation directly visibility deteriorated to a dangerous level.

For a quite modest outlay of about £4 the motorist could equip his vehicle with an extremely useful, and maybe life-saving, electronic aid.

Fred Bennett

Our June issue will be published on Friday, May 17

EDITOR F. E. Bennett • ASSISTANT EDITOR M. Kenward • B. W. Terrell B.Sc.

ART EDITOR J. D. Pountney • P. A. Loates • K. A. Woodruff

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..EASY TO CONSTRUCT
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VOL. 3 NO. 5

MAY 1974

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Electronic simulation of the bagpipe sound.

THIS instrument is an attempt to simulate, fairly simply, the sound and method of playing the bagpipes. The finished instrument is also capable of producing other types of sound and is fitted with a vibrato effect and switching for the drone sound in the bagpipe simulation.

CIRCUIT

The complete circuit diagram is shown in Fig. 1, TR3 is the main unijunction oscillator (chanter oscillator) which is fine tuned by VR2 wired in series with resistors R19 to R26. These resistors being inside the chanter. Transistor TR2 forms a vibrato oscillator which can be switched off and on as desired, by the tone switch S1. This same switch in another position will operate the drone oscillator (TR1). This is necessary for simulation of bagpipes.

The drone oscillator has a larger value tuning resistor VR1, which allows the drone to be tuned to either the treble or bass end of the scale as desired. Both oscillators are fed to TR4 via resistors R12 and R13; it will be noticed R13

is a higher value than R12, so that the chanter will be predominant while playing the pipes.

Transistor TR4 is a signal amplifier the output of which is fed to a screened lead via the tone forming network comprising C10, C12, C13 and R18. These components suppress some of the higher harmonics, and make a more realistic bagpipe sound. Switch S2 is simply a micro-switch wired in series with battery B1. It is situated in such a position that by squeezing the unit with the elbow, S1 is closed and switches the unit on for playing. The unit is switched off when pressure is released. This leaves both hands free on the chanter to enable the player to start, or end a tune on any note desired.

It will be seen that with the tone switch in position one, the bagpipe sound is produced; in position two only the main oscillator is in circuit. This will give a sound not unlike the clarinet, but adjustments of controls on the amplifier it is plugged into, could make a lot of difference to the tone. In position three, the sound is modulated by the vibrato, and becomes a pleasing sound, not unlike an organ.

CONSTRUCTION

As seen from the Fig. 2. most of the components are mounted on a Veroboard panel

ELECTRONIC BAGPIPES

BY T. RICHARDSON

measuring 20 holes by 13, the copper strips running along the 20 holes. The strips are cut at the points marked on the underside drawing and all the components are laid out in straight lines from top to bottom; it must be noted that components (C2, R13; C7, R8; C9 and R12) are stood up on end and the junctions are **not** connected to the panel after wiring.

This panel can be tested on its own, by connecting in VR1 and a temporary connection from VR2 free end to battery positive. Either connect phones across the output or feed into an amplifier, connect the battery positive and negative. This should cause the chanter oscillator to function, adjustment of VR2 should change the pitch by about two or three notes.

Now connect the wire from C1/R2 to negative, and the drone will be heard, VR1 should alter the drone by well over an octave. If all is well, connect a wire from R7 to negative and test the vibrato.

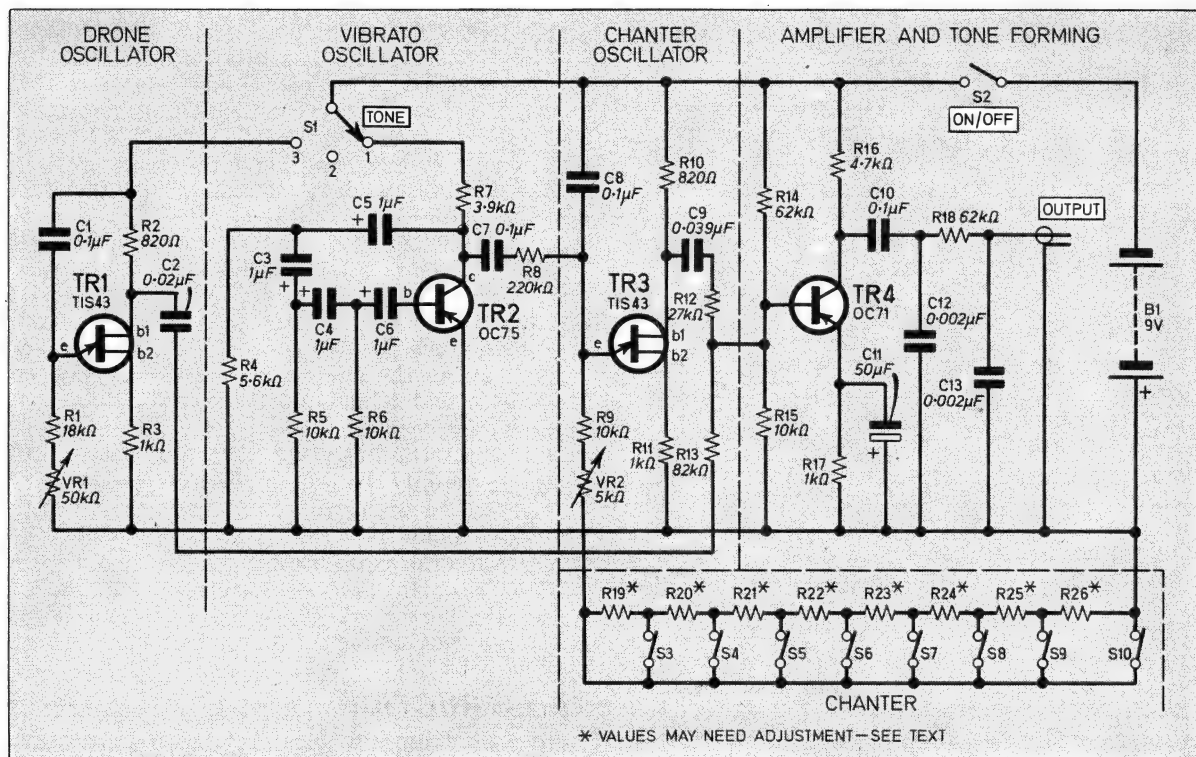


Fig. 1. Complete circuit diagram of the Electronic Bagpipes.

Components....

Resistors

R1	18kΩ	R14	62kΩ
R2	820Ω	R15	10kΩ
R3	1kΩ	R16	4.7kΩ
R4	5.6kΩ	R17	1kΩ
R5	10kΩ	R18	62kΩ
R6	10kΩ	R19	1kΩ
R7	3.9kΩ	R20	3.3kΩ
R8	220kΩ	R21	2.4kΩ
R9	10kΩ	R22	1.2kΩ
R10	820Ω	R23	2.2kΩ
R11	1kΩ	R24	1.5kΩ
R12	27kΩ	R25	2.1kΩ
R13	82kΩ	R26	620Ω

All $\pm 5\%$ $\frac{1}{4}$ W carbon

SEE
**SHOP
TALK**

approximate
values,
may need
alteration
to tune
chanter

Capacitors

C1	0.1μF
C2	0.022μF
C3	1μF
C4	1μF
C5	1μF
C6	1μF
C7	0.1μF
C8	0.1μF
C9	0.039μF
C10	0.1μF
C11	50μF elect. 12V
C12	0.002μF
C13	0.002μF

may be
elect. 12V

Potentiometers

VR1 50kΩ lin carbon
VR2 5kΩ lin carbon

Semiconductors

TR1 TIS43 unijunction
TR2 OC75 germanium *pnp*
TR3 TIS43 unijunction
TR4 OC71 germanium *pnp*

Switches

S1 single pole three way wafer switch
S2 push to make single pole microswitch
S3-S10 push to break single pole miniature push buttons (8 off)

Miscellaneous

B1 9V PP3 battery
Knob to suit S1, screened lead, 25mm diameter plastic tube 270mm long, materials for case, connecting wire, Veroboard 13 strips by 20 holes by 0.15 inch matrix, 4 BA fixings, plastic or Formica for fascia panel.



**Approximate cost
of components
including V.A.T.**

**excluding case
£6.00**

ELECTRONIC BAGPIPES

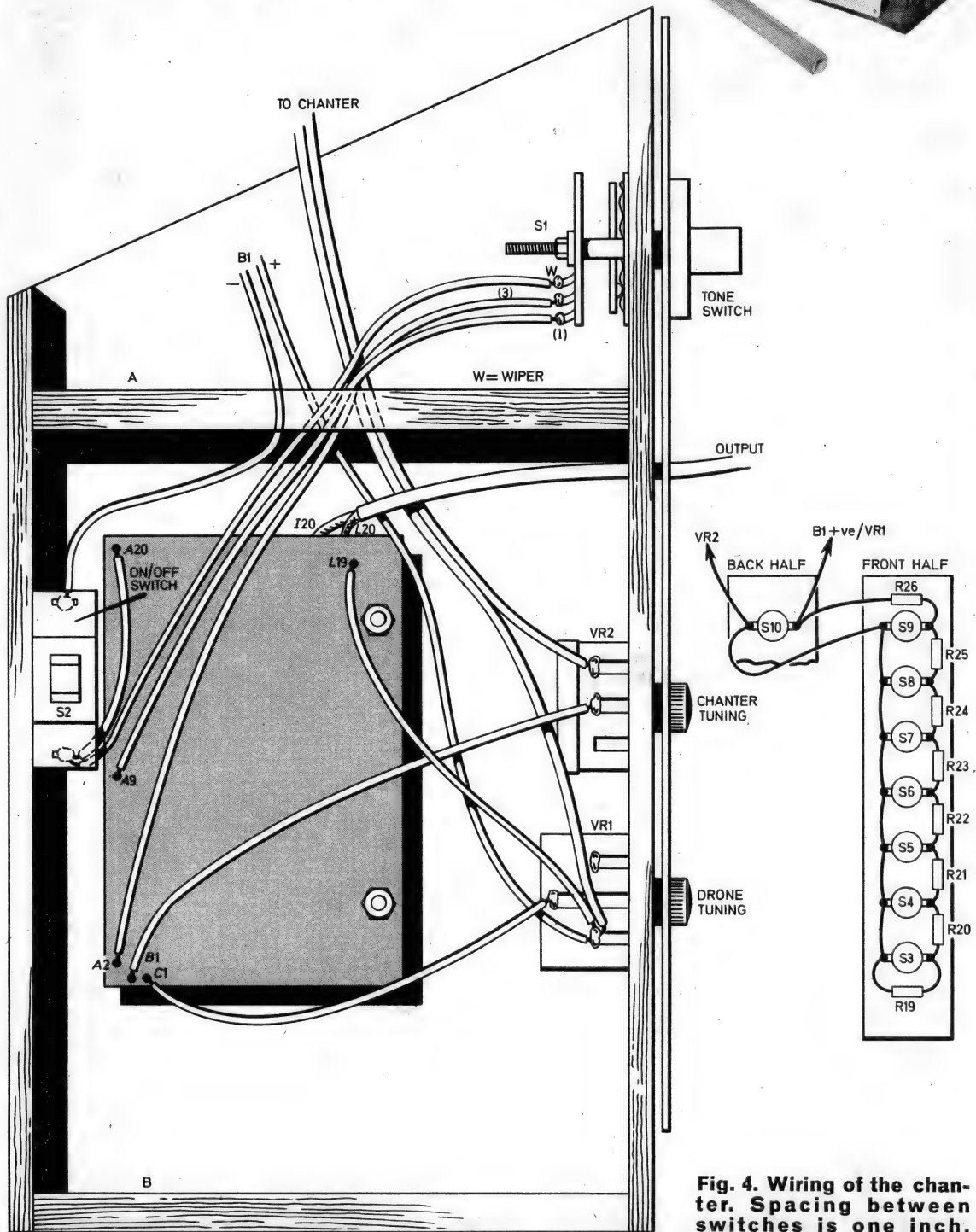
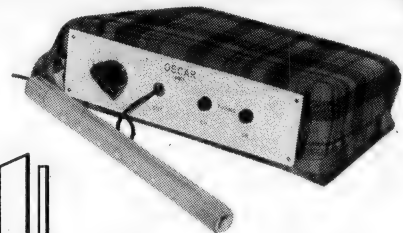


Fig. 3. Layout and wiring of the components inside the case.

Fig. 4. Wiring of the chanter. Spacing between switches is one inch. Switch S10 should be mounted $\frac{1}{2}$ inch above S9.

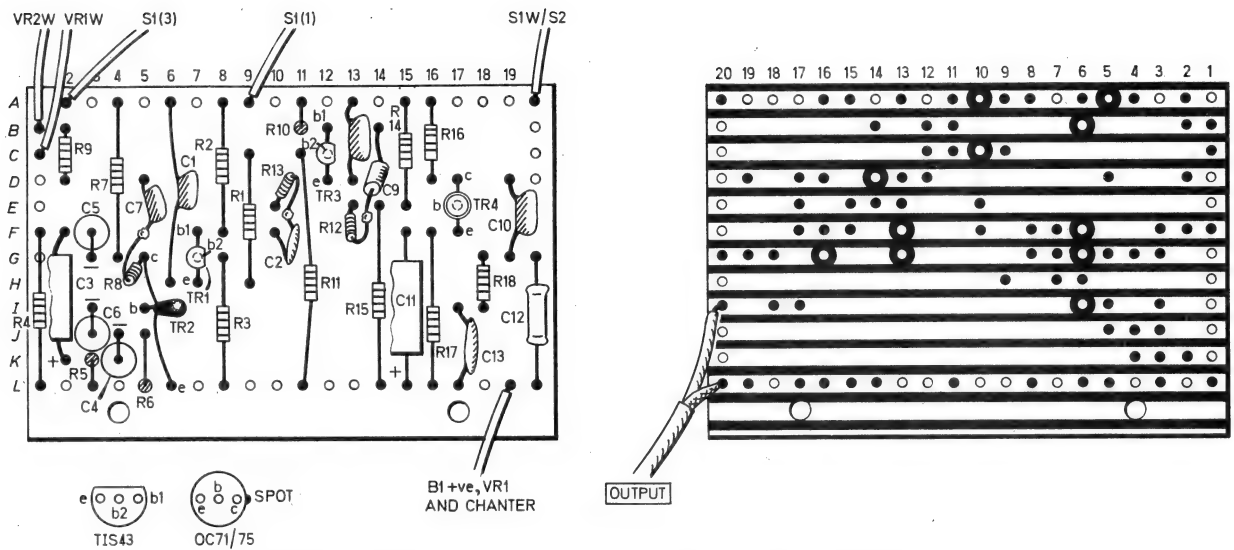


Fig. 2. Component layout and wiring on the Veroboard.

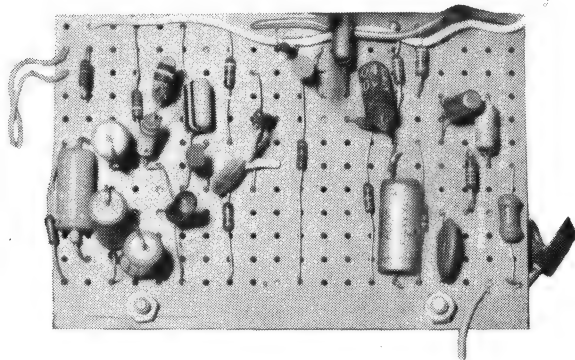
It should be mentioned at this point that R4 (5-6 kilohm) and R8 (220 kilohm) are used in the prototype, but may be adjusted to suit individual requirements, R4 controls vibrato speed and R8 the amplitude. An OC75 transistor or similar is used in the vibrato and must be a high gain type, TR4 is an OC71, but this could be any similar transistor. TR1 and TR3 are both unijunction type TIS43 but similar alternatives can be used.

CASE

A box must be assembled in the way shown in Fig. 3, but at this stage the top panel is not fixed. The left hand panel in Fig. 3 is 6mm narrower than the rest. The two upright supports (A and B in Fig. 3) should be tapered from halfway along, to the side panel. This allows the top panel to be squeezed in under the armpit, to actuate the microswitch S2.

After drilling holes on the side panel to accommodate controls VR1 and VR2, and switch

Photograph of the component board.



S1, the components may be mounted inside the case.

Switch S2 must be bolted to the side panel near the front edge, so that the actuator will be pressed in when the side panel is pushed onto it.

After all the wiring is completed as shown in Fig. 3 the side panel is screwed on, with two screws near the right hand side. Finally the case is covered in thin foam rubber and a tartan bag covers the whole unit. This bag may either be tacked or glued to the control panel, and the fascia screwed on to finish the unit off (see photographs).

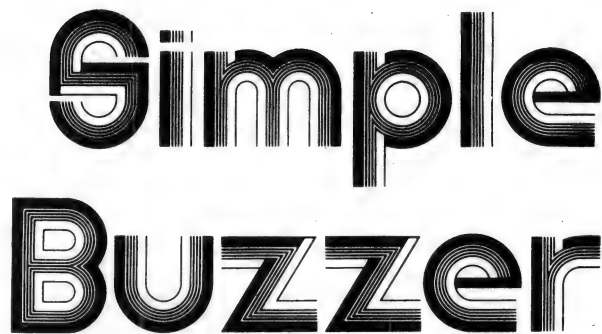
CHANTER

The chanter is made by sawing 25mm diameter plastic tube (such as water pipe etc.) down the centre and drilling suitable sized holes to take miniature push button switches. After wiring to Fig. 4, join the two halves together.

The chanter resistors are chosen to play the diatonic scale. To select the proper key R9 may have to be varied, so as to play the top note of the scale with VR2 near mid travel.

PLAYING

The unit is plugged into an amplifier of almost any type. A suitable design will be published in our July issue. The instrument is placed under the arm, control panel downwards, and squeezed. Switch to position two or three and once you're certain the chanter is tuned properly, switch to position one and tune drone to either top, or bottom note. When fingering this instrument the same method is used as for playing a tin whistle or similar instrument, i.e. the highest note left open is sounded. □



**An audible warning device
useful for many applications**

**Approximate cost
of components
including V.A.T.**

£1.50 inclusive

The circuit diagram of the Simple Buzzer is shown in Fig. 1, and operates as follows.

When the supply is connected, C1 starts to charge up via VR1, and when a certain voltage level is reached at the junction of VR1 and C1, the transistor starts to conduct.

The change in voltage across the earpiece, TL1, induces a voltage in L1 which tends to help TR1 turn on (positive feedback), TR1 thus turns on very quickly. When TR1 is fully on, the voltage induced in L1 reduces to zero and C1 discharges through TR1 base/emitter; as this occurs, the voltage on TR1 base is reduced, and a point is reached when TR1 starts to turn off.

The voltage change across TL1 is now in the opposite direction and this induces a voltage in L1 which assists TR1 to turn off.

When TR1 is fully off the cycle repeats itself—thus producing an audible tone. The frequency of the tone is dependant on the values of VR1 and C1. Reducing VR1 will enable C1 to charge up more rapidly and thus increase the frequency, i.e. a higher pitched tone.

The components can either be mounted inside the earpiece itself, as in the prototype, or may be mounted separately on a piece of Veroboard or printed circuit board.

It is necessary to dismantle the earpiece and remove the coil; with this done, wind on 10 turns of 26 s.w.g. enamelled copper wire and replace the coil. Mount the other components in the earpiece as shown in Fig. 2.

If this exact type of earpiece is not used it may be necessary to redesign the layout of the components or alternatively an exterior circuit board will have to be employed.

Turn the potentiometer VR1 to its maximum resistance position and switch on.

With a small screwdriver, turn VR1 until a tone emanates from the earpiece. If the buzzer

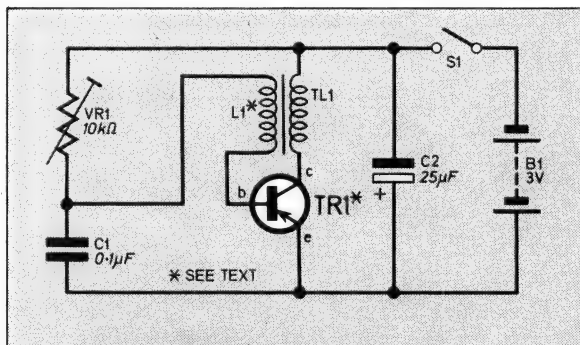
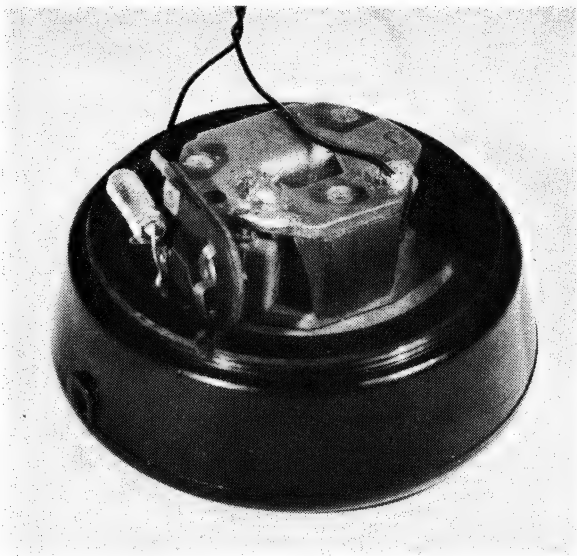


Fig. 1. Circuit diagram of the complete Simple Buzzer.



Photograph of the original unit with part of the case removed.

refuses to oscillate, even when VR1 is one quarter of the maximum value, interchange the connections to the added feedback windings, and repeat the above procedure. The buzzer, when correctly set up can be activated by closing S1, this is useful when used as a door buzzer; if

Components....

Capacitors

C1 0.1 μ F

C2 25 μ F elect. 12V

Potentiometer

VR1 10k Ω skeleton preset

Transistor

TR1 2N3702 silicon *pnp* or any similar transistor

Miscellaneous

L1 26 s.w.g. enamelled copper wire

S1 on/off switch if required, e.g. door bell push, etc.

B1 3V battery (2 x U2 etc)

TL1 ITBA No. 5 or any balanced armature earpiece of approx. 50 ohms to 100 ohms impedance.

Connecting wire.

used in an alarm circuit, the switch can be replaced by a set of relay contacts or a thyristor.

COMPONENT NOTES

The earpiece used in the prototype was one from an army field telephone unit, type ITBA No. 5. It has a coil resistance of 50 ohms. This type and similar earpieces should be available from government surplus stores.

The transistor type is not critical, almost any *pnp* transistor with a gain (h_{fe}) greater than 20 would do. ▣

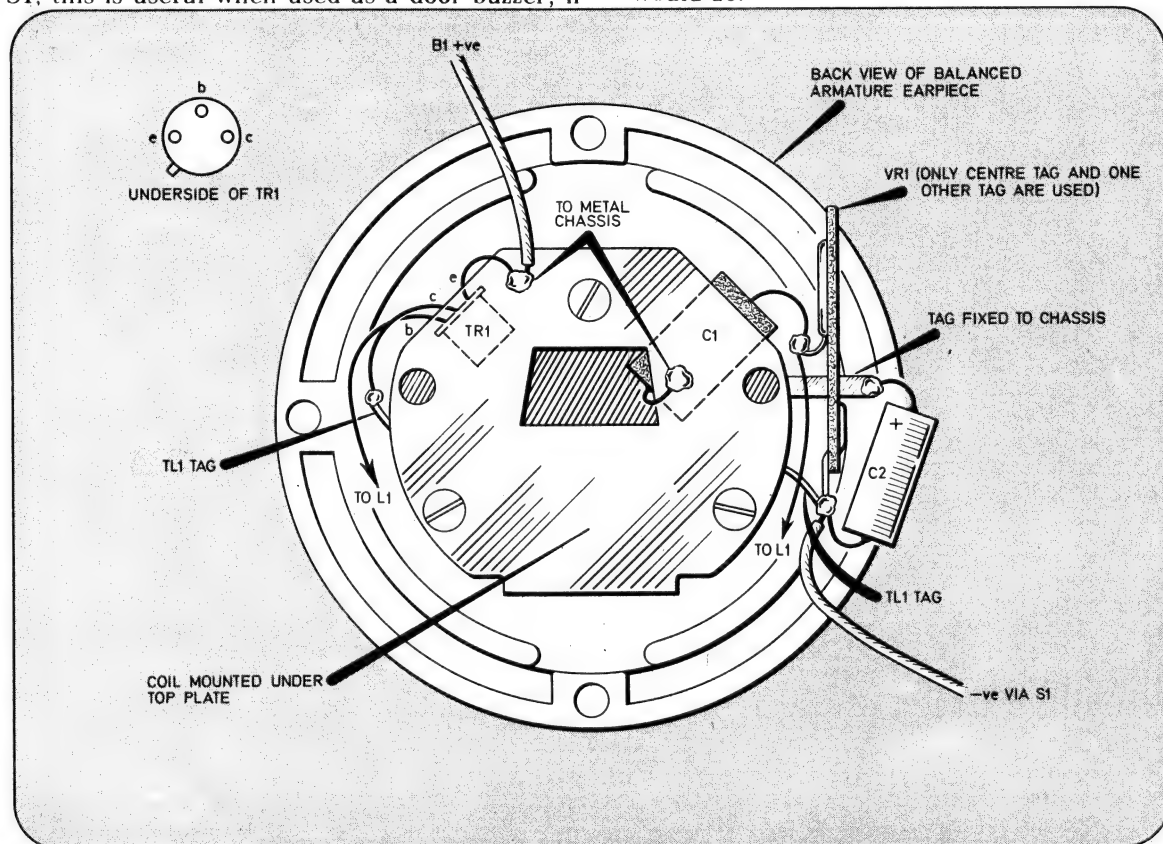


Fig. 2. Complete layout and wiring of the simple buzzer.

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS...
THEORY AND EXPERIMENTS

TUTOR: PHIL ALLCOCK*

LESSON 8 The Astable and Alternating Current

THIS month we examine the astable multivibrator and go on to look at some new ideas and theory relevant to basic circuit elements, in order to extend the range of electronic circuits that can be covered in the remainder of the Teach-In '74 series. The additional components required for the Tutor Board experiments for future parts are listed later.

ASTABLE CIRCUIT

The astable circuit does not have any permanent stable states and switches continuously between two temporary states. The basic idea follows on quite naturally from the previous monostable but the circuit is modified so that a second charge/discharge timing element is introduced between point Z and the base of TR2 in Fig. 7.4 of last month.

Instead of the switching state being controlled directly from point Z it is controlled instead by a duplicate of the coupling circuit C1, R1. The simplest arrangement is illustrated in Fig. 8.1 where it can be seen that the astable consists

of two similar timing circuits connected so that the transistor of either circuit acts as the "switch" for the other "half". Consequently the recharging of (say) C2 via R2 determines the instant at which TR2 can switch from off to on and it is the switching on of TR2 which initiates the timing interval during which C1 can recharge via R1.

This recharging of C1, in turn controls the switch on instant of TR1, which in turn controls the start of the timing interval for TR2 again. The cycle of events continues indefinitely and as one transistor switches on the other is automatically switched off for a time duration determined by the choice of C—R values.

It is not necessary to have $C1 = C2$ or $R1 = R2$ although the maximum values of R1 and R2 are limited in this circuit by the need to ensure adequate current for the lamps LP1, LP2.

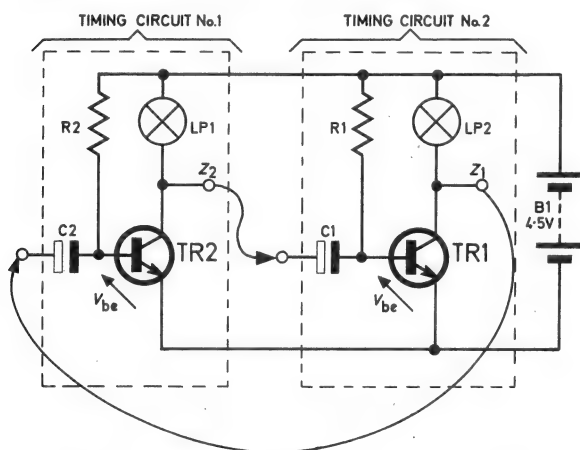
In normal circumstances the circuit will start operating as soon as the supply voltage is connected but occasionally both transistors can switch on together, in which case the circuit will not self-start. This failure to start sometimes occurs when the supply voltage builds up slowly, as can happen when the circuit is operated from a power supply derived from the mains, but is less likely to happen when the two timing circuits are made dissimilar by using (say) different values for C1 and C2, with $R1 = R2$.

The waveforms of base voltage against time for the two transistors are illustrated in Fig. 8.2 for the case where C1 is larger than C2 and R1, R2 are equal. The recharging of C1 via R1 involves the larger time constant and this makes the on/off times unequal. For equal on/off durations the transistors must be "identical" and the two time constants must be equal.

VOLTAGE REVERSAL

In both the monostable and the astable circuit we have seen that the voltage at the base of the transistor reverses at the instant of switching,

Fig. 8.1. The astable multivibrator.



* North Staffordshire Polytechnic. Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4).

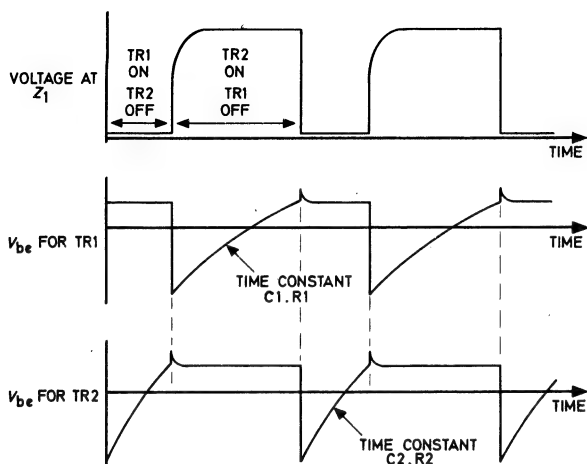


Fig. 8.2. Voltage waveforms for the astable multivibrator.

due to the charge storage characteristic of the capacitor and in some circuits the reverse bias across the base/emitter junction can exceed the safe reverse voltage rating given by the manufacturer. For the BC107 device this rating is given as:—

$$V_{cbo}(\text{max}) = 6.0 \text{ volts}$$

Consequently when a supply voltage of more than 6.0 volts is employed there is a risk of transistor damage, or circuit malfunction, since we have already shown that the instantaneous value of the reverse bias has a maximum value which is only about 500mV less than the supply voltage used. For the circuits shown in Fig. 7.4 and 8.1 this voltage is about 4.0 volts and is within the transistor rating.

It is often necessary to operate a circuit such as the astable from a supply voltage considerably larger than the 6.0 volt V_{cbo} rating (which is incidentally a typical value for many modern silicon transistors). Certain modifications can be made to the basic circuit to protect the transistor emitter/base junctions from excess reverse voltage and two possibilities are shown in Fig. 8.3.

In Fig. 8.3a a silicon diode is used in series with the transistor base lead so that when the voltage reversal occurs the higher reverse voltage rating of the diode (typically 50 volts or more) protects the transistor junction against possible breakdown. The reverse voltage is shared between the diode and the transistor junction and since the diode will maintain a very high back resistance even when subjected to large reverse voltages, the current flow is severely restricted and breakdown cannot occur.

The forward voltage drop across the diode increases the voltage level at which the transistor turns on, and with a silicon diode the voltage V_1 in Fig. 8.3a will become clamped at about 1.0 volt instead of the previous value of approximately 0.5 volts. Fig. 8.3b works in a similar manner but has the additional effect of raising

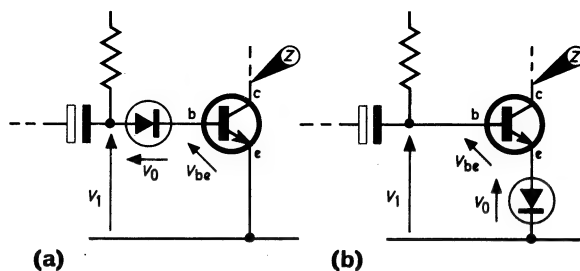


Fig. 8.3(a). Protection by base diode (b) protection by emitter diode.

the voltage level at point Z, when the transistor saturates, due to the diode voltage drop.

Since the change of voltage at point Z determines the negative excursion at the base of the other transistor, the emitter connected diode will reduce this excursion by about 0.5 volts. Note that V_1 for the emitter diode arrangement will be slightly larger than V_1 for the base diode circuit because the emitter connected diode must carry the full emitter current of the transistor and as a result will have a larger forward voltage drop, V_0 . The only effect of these small differences is that the circuit timing changes slightly but this need not concern us here.

OFF TIME AND FREQUENCY OF OPERATION

We have seen that the transistor TR1 in Fig. 7.1 turns off for a short interval immediately the switch is closed. The “off time” can be obtained by considering the waveform shown in Fig. 7.3 which shows that TR1 remains off for the interval $(t_2 - t_1)$. During this interval the capacitor voltage V_c changes from +4.0 volts to -0.5 volts and it can be shown that the “off time” is given by the following equation.

$$\text{“off time”} = (C1 \times R1) \log_e \left[\frac{1}{1 - N} \right]$$

Where N is the ratio of the actual change in the voltage V_c , to the maximum change that would occur if the emitter/base clamping action was not present. For our circuit this ratio is:

$$N = \frac{4.0 - (-0.5)}{4.0 - (-4.5)} = \frac{4.5}{8.5} = \frac{9}{17}$$

The symbol \log_e means natural logarithm and is given in books of mathematical tables.

For our circuit:

$$\log_e \left[\frac{1}{1 - N} \right] = \log_e \left[\frac{17}{8} \right] = 0.75$$

In fact N is always approximately equal to one half because the actual change of capacitor voltage is nearly equal to the supply voltage whilst the maximum voltage change is about twice this value. (For $N=0.5$ the \log_e term would be 0.7 approximately). We have therefore a simple way of estimating the off time as 75 per cent of the

CR constant. If $C1=1000\mu\text{F}$ and $R1=4.7\text{k}\Omega$ the off time will be given by:—
 “off time” = $(0.75 \times 4.7 \times 1000)$ milliseconds, which is approximately 3.5 seconds.

In the case of the astable circuit one complete sequence of events, called a cycle, will take a time that is the sum of the individual off times for the two halves of the circuit. The “number of cycles” that occur in one second is known as the frequency. One cycle per second is called one hertz (Hz).

We can express these circuit parameters as follows:

Total “off time” $0.75 (C1.R1 + C2.R2)$ and if $C1.R1 = C2.R2 = T$ say, then

$$\text{Frequency} \frac{1}{(1.5 \times T)} \text{ Hz. (must be in seconds)}$$

It must be noted that this result is only approximate but does give a simple method of estimating the circuit frequency.

The astable circuit is just one of many oscillator circuits that can generate voltages (in this case at either the transistor collectors or bases) which are periodic i.e. have a repetitive waveform. The normal household mains supply is another example of a periodic (alternating) voltage, and has a smoother waveform than the square wave output produced at the collectors of the astable multivibrator circuit.

REFERENCE OR COMMON CONNECTIONS

Most of the circuits covered so far have involved currents and voltages that were either steady, or that varied in magnitude (but not polarity) with time. In many circuits one side of the power supply is taken as the common or ground side even though no connection is actually made to “ground or earth”.

This concept of a common point or datum is useful since we can refer our measurements to this point and in Fig. 8.4 a circuit is shown that in effect uses two separate power supplies B1, B2 which provide opposite polarity. With reference to the datum or common point, B1 provides a positive voltage to one end of R1 and therefore sets up an emitter current in TR1.

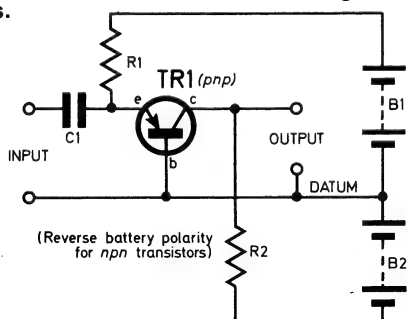


Fig. 8.4. Common base amplifier using two power supplies.

The collector current flows via R2 which is supplied with a negative voltage (relative to datum) by B2. The small base current must flow in the datum lead which is common to input, output, B1 and B2.

We have seen that it is possible to produce a reversal of voltage polarity in the astable multivibrator (Fig. 8.2) and in many electronic circuits alternating voltage and current waveforms of this type are produced.

ALTERNATING WAVEFORMS

It is not necessary for all alternating waveforms to have the same shape as Fig. 8.2 and some other common variations are illustrated in Fig. 8.5. In Fig. 8.5a the waveform is smooth and there are no abrupt changes.

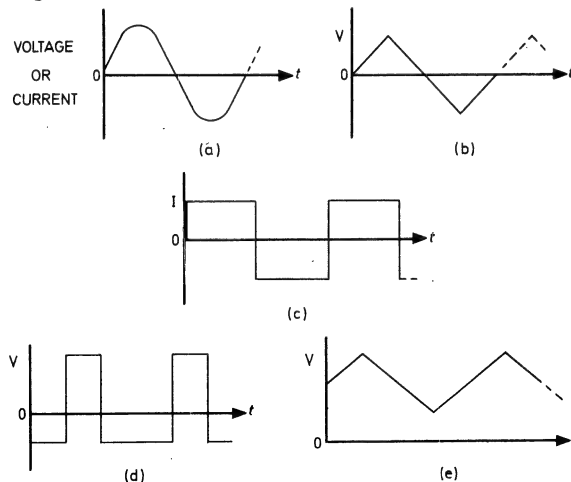
An example of such a waveform is the household mains supply and in this case the waveform is very nearly **sinusoidal**. This simply means that the voltage or current varies with time according to the mathematical sine function and can therefore be expressed by $V = V_m \sin(2\pi ft)$. We will come back to this expression later on.

The Figs. 8.5b and 8.5c show a triangular waveform and a square waveform respectively. Notice that in each of these examples the waveform “shape” repeats itself at regular intervals and that the waveform is symmetrical insofar as the shape of the positive and negative portions are mirror images of each other.

In Fig. 8.5d we have a “repetitive pulse” waveform. The waveform still repeats its particular shape at regular intervals but the waveform symmetry is no longer present since the positive portions are “tall and narrow” whilst the negative portions have smaller amplitude and greater width.

Actually it is somewhat artificial to consider the waveform as two portions, positive and negative, but at this stage we shall find the idea useful for discussion purposes.

Fig. 8.5. Some common waveforms.



The waveform in Fig. 8.5e is not, strictly speaking, an alternating waveform, since it is always positive, but it can be considered to be made up of two parts. If we add a steady positive voltage to an alternating voltage such as that in Fig. 8.5b we can produce a waveform exactly like that in Fig. 8.5e. This idea of breaking a waveform into steady and alternating portions is also very useful.

AVERAGE VALUES

Waveforms that contain alternating and steady components are very common and the steady component is known as the average value of the waveform. The meaning of this is best illustrated by considering the current waveforms shown in Fig. 8.6. In (a) the waveform is symmetrical and the shape repeats itself every two milliseconds. We say that the periodic time is 2ms since this is the time occupied by the waveform in tracing out its characteristic shape for one complete cycle of variation.

The waveform is made up by a series of such cycles and the number of cycles that occur every second is known as the frequency, measured in hertz (Hz). Thus the waveform of Fig. 8.6a can be described by the following:—

shape—squarewave

period—2ms (for one complete cycle)

frequency—500Hz (number of cycles per second)

other features—symmetrical ± 1 A, average value zero.

The zero average value results from the perfect symmetry of the positive and negative half cycles. The area under the positive half cycle is $(1\text{amp}) \times (1\text{ms})$ and represents a flow of charge of one millicoulomb in a given direction through some circuit. The area under the negative half cycle represents an equal amount of charge flowing in the opposite direction. The nett or average flow is therefore zero over one or more complete cycles of the square waveform.

A similar shape is illustrated in Fig. 8.6b but this time the current is either 2A or zero. The period, frequency and peak to peak current swing (2A) are the same as before but this time the average value is not zero. Every complete cycle a charge of 2mC is passed round the circuit in the positive direction—nothing is ever passed back in the reverse direction. The

average flow is therefore 2mC every 2ms and is equivalent to an average current of 1 ampere.

This can be seen in Fig. 8.6b since if the top half of each rectangle is removed and used to fill the following space a continuous constant current of +1 ampere results. It is easy to see that by adding a constant current of one ampere to the waveform of Fig. 8.6a the waveform of Fig. 8.6b results.

A.C. THEORY

To extend our knowledge of electronic circuits it is necessary to examine the behaviour of all our previous components under alternating conditions. In fact to gain a full understanding of the behaviour of components it is necessary to consider time varying current or voltage waveforms in general and fortunately this is possible by introducing one fundamental concept—namely the idea of rate of change. If the voltage across a capacitor is varying with time the current flow will be given by

$$i = C \times \text{rate of change of voltage.}$$

If C is in farads and the rate of change is in volts per second the current will be in amperes. If the rate of change of voltage is varying with time then the current will vary in a similar manner. To illustrate some of the possibilities let us consider Fig. 8.7. Diagram (a) shows a voltage which is rising uniformly with time. In this case the rate of change is *constant* and is equal to the slope of the line which is +20 volts per second. Since the capacitor has a fixed value of $1000\mu\text{F}$ the current will be constant and equal to:

$$\text{Current} = 1000 (\mu\text{F}) \times 20 (\text{V/s}) = 20,000\mu\text{A} = 20\text{mA}$$

As long as the rate of change of voltage is maintained constant at 20 V/s the current will remain at 20mA. After say ten seconds the capacitor voltage will have increased from zero to +200 volts and the charge, Q , stored in the capacitor will be

$$\begin{aligned} Q &= C \times V \\ &= 1000 (\mu\text{F}) \times 200 (\text{V}) = 0.2 \text{ coulomb} \end{aligned}$$

Notice that this result agrees with the charge transferred by the current flow using

$$\begin{aligned} Q &= i \times t \\ &= 20 (\text{mA}) \times 10 (\text{s}) = 0.2 \text{ coulomb} \end{aligned}$$

A voltage that rises and falls in a regular way is illustrated in Fig. 8.7b, if this voltage appeared

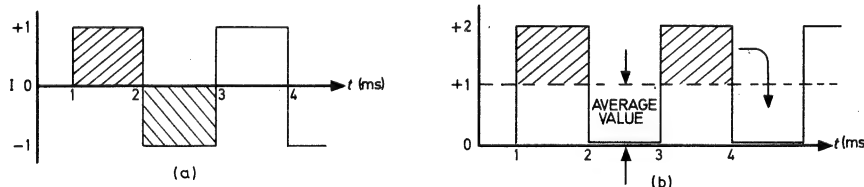


Fig. 8.6. Illustrating average values.

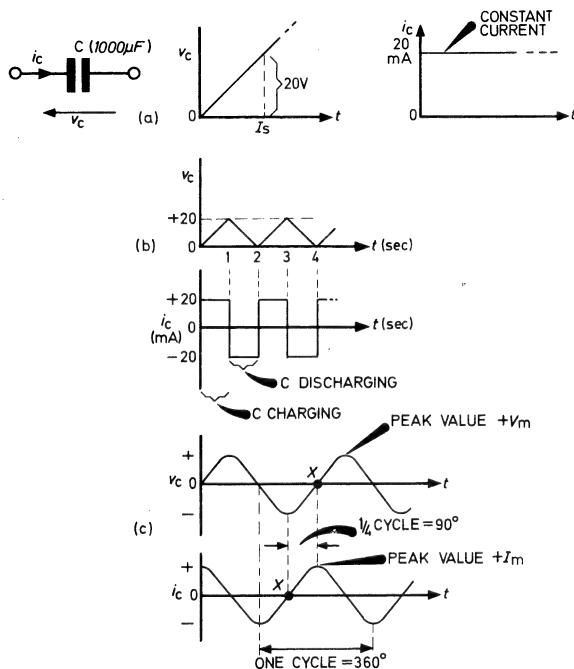


Fig. 8.7. Voltage and current waveforms for a capacitor.

across a capacitor C the resulting current would be a square wave. The current is positive when the voltage has a positive rate of change of $+20$ volts per second, whereas the current flow is reversed (i.e. negative) when the voltage falls at 20 volts per second. A falling voltage gives a negative rate of change.

Notice that the capacitor is charging when the current is positive and discharging when the current is negative, Fig. 8.7c illustrates the be-

haviour when the capacitor voltage is a sine wave. At the positive and negative voltage peaks the rate of change (i.e. slope of the waveform) is zero. The current waveform has the same sinusoidal shape but it is displaced in time relative to the voltage waveform.

The displacement is seen to be equivalent to a shift of a quarter of one cycle and since one complete cycle corresponds to a change of 360 degrees in the angle θ of a sine function, such as $10 \sin \theta$, the displacement can be expressed as a shift of phase of 90 degrees. The current is said to *lead* the voltage by 90 degrees since it passes through any specified point, such as X , 90 degrees ahead of the corresponding point on the voltage variation.

INDUCTANCE

When current flows in a wire or conductor a magnetic field is set up in the vicinity. If the wire is formed into a coil the magnetic field links the various turns and this gives rise to the property known as inductance. In our previous experiments we have not needed to use this property which is incidentally always present to some degree, just as stray capacitance is always present, in electronic circuits.

Some components utilise the magnetic effects produced by current flow and two well known examples are the relay and transformer.

Next month we shall look at inductance in a.c. circuits and go on to examine reactance, resonance and r.m.s. values.

For the experimental work of the remainder of the Teach-In '74 series, some additional components will be required; these are listed on this page.

Components

Capacitors (Additional to those listed in Part 1)
 $0.22\mu\text{F}$ polyester (2 off)

Semiconductors

IN4001 silicon diodes (3 off)
 TIS43 unijunction transistor (1 off)
 2N3819 field effect transistor (1 off)
 BC477 silicon *pnp* transistor (1 off)
 BTX30-25 triac (1 off)

Loudspeaker

35Ω 65mm (approx) (1 off)

Miscellaneous

Friedland bell transformer 8V secondary (1 off); Ferrite rod 150 to 200mm long, 10mm ($\frac{3}{8}$ in) diameter (1 off); 30 s.w.g. enamelled copper wire (2 oz. reel); Plastic cotton bobbin (1 off from Woolworths); Reed switch type 6-RSR-A (1 off). 12-way terminal block—similar to that already in use.

TUTOR BOARD EXPERIMENT

Test No. 19

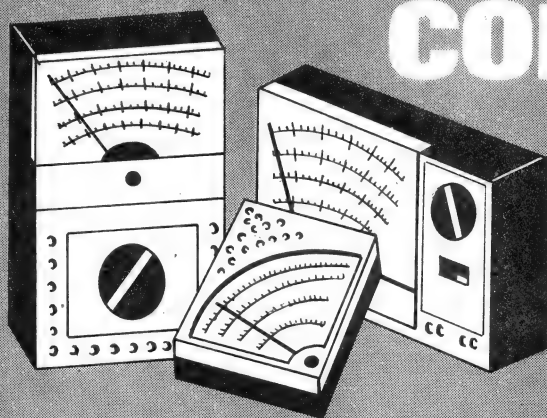
Disconnect the battery and modify the Tutor Board wiring to match the circuit of Fig. 8.1. Use 4.7 kilohm resistors for R_1 and R_2 and check the operation of the circuit for each of the following capacitor values in turn. Observe capacitor polarity!

1. C_1 and C_2 both $250\mu\text{F}$.
2. $C_1 = 1000\mu\text{F}$; $C_2 = 250\mu\text{F}$.
3. $C_1 = 1000\mu\text{F}$; $C_2 = 125\mu\text{F}$ (made from two $250\mu\text{F}$ capacitors in series).

The on state for each transistor is indicated by the lamps and the voltage at Z_1 and Z_2 can be examined using the standard 0-10V voltmeter circuit. The layout for this test is left as an exercise for readers. The effect of the different capacitor values can be determined by observing the "on time" of the lamps.

NEXT MONTH ...

FREE ENTRY COMPETITION



*Multimeters
to be **WON***

Plus 3 Constructional Projects...

80m and 160m AMATEUR BANDS RECEIVER

Ordinary a.m. receivers are unsuitable for single sideband reception and also for the other main transmission mode used by amateurs, carrier wave (morse code). The most simple type of receiver suitable for amateur band reception is the direct conversion type and the construction of such a receiver covering the 80 metre and 160 metre bands will be described next month.

FREEZER TEMPERATURE ALARM

Many homes now possess a deep freeze unit and it is logical, particularly if the unit is fitted in a garage or other "outbuilding", to have an indicator available in the house to show that a temperature variation has occurred before the contents of the freezer are spoiled. The unit to be described next month indicates any rise or fall in the temperature with an audible and visual warning.



5th. Instrument

R.F. SIGNAL GENERATOR

everyday electronics

JUNE ISSUE ON
SALE MAY 17

TRANSISTOR TESTER

Gives a direct reading of six transistor parameters

ENTHUSIASTS spend a large proportion of their time testing and commissioning electronic circuits. Transistors employed within these circuits can become suspect and therefore a simple transistor test meter is an asset. The Transistor Tester described in this article is cheap and simple to build yet checks the basic parameters of the transistor under test. These parameters are static forward current transfer ratio (h_{FE}), collector leakage current (I_{CEO}) and base/emitter, base/collector forward and reverse resistance.

The instrument functions with a supply voltage between 10 and 20 volts, which is within the range of the *Power Supply Unit* described in the February issue.

TEST SYSTEM

The meter measures gain by injecting a known current I_B into the base of the transistor under test and monitoring the collector current I_C . This gives a direct reading of gain which satisfies the formula:

$$h_{FE} = \frac{I_C}{I_B}$$

Large changes in collector current or collector/emitter voltage affect the transistor gain. The Transistor Tester is designed so that these variations are small enough to be ignored.

As the symbol, I_{CEO} indicates, the meter ascertains the level of collector leakage current by leaving the base open circuit and applying a constant voltage across the collector/emitter junction, V_{CE} . Indicated current flow is the leakage current taken from the collector supply.

Fig. 1 shows that when subjecting an *npn* transistor to resistance checks the transistor acts as two *pn* junctions connected back to back. This enables the junctions of the base/emitter and base/collector to be treated as two diodes. A similar mechanism explains how the system makes resistance checks of *pnp* transistors. However, as the doping in each region is reversed, the diode connections need to be inverted to obtain the same action.

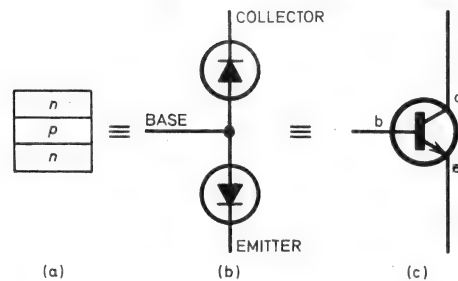


Fig. 1. (a) Schematic layer representation (b) diode representation (c) circuit symbol of an *npn* transistor.

THE CIRCUIT

The complete circuit diagram, Fig. 2, shows switch S1 set to *npn* and therefore the collector voltage of the transistor under test is positive with respect to the emitter. A voltage of 4-7V drives the base of the transistor via resistors R2, R3 and R4 depending on the position of the gain switch S4.

A maximum collector current of 10mA provides a suitable and safe value for testing general purpose transistors. The meter used to indicate the gain is connected in series with collector, via switches S1, S2 and S3, and because it is 1mA full scale deflection (f.s.d.), it is shunted with R5 to give the required 10mA f.s.d. Thus by switching S4 the unit can measure a direct gain up to 1000.

Testing a transistor whose collector and emitter are short circuited will cause a large current



Approximate cost of components including V.A.T.

£7.30

excluding case

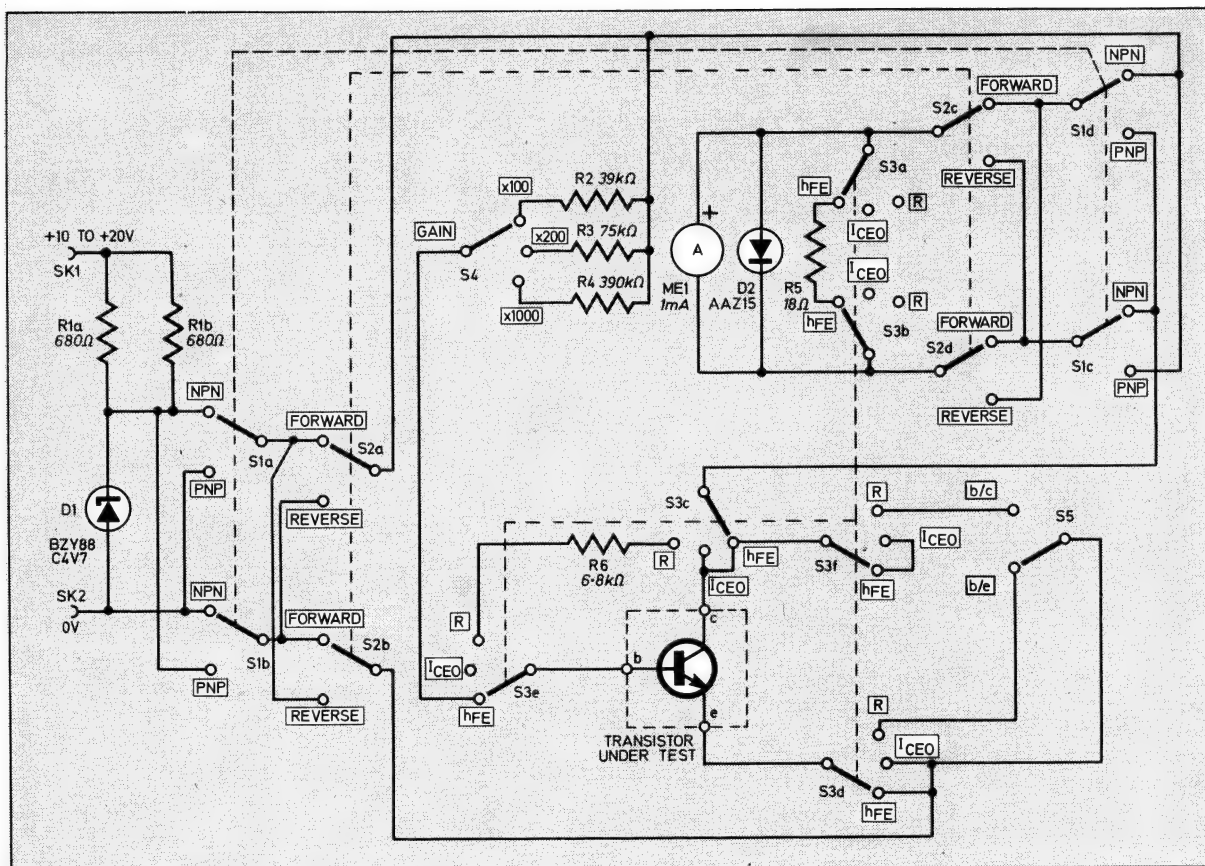


Fig. 2. The complete circuit diagram of the Transistor Tester.

to pass through the meter. To protect the meter against damage, a germanium diode D2 is connected across it. However, the internal resistance of the meter must be about 170 ohms. The short circuit fault in transistors will cause the meter to register hard over in all positions of switch S4, also when S3 is switched to check leakage.

As most leakage currents are in the order of a few microamps the meter is not shunted, so the 1mA f.s.d. will indicate a "leaky" transistor. Switching S3 from position shown removes the shunt resistor R5 and open circuits the base connection (at S3e) thereby giving a direct indication of leakage current (I_{CEO}).

FORWARD/REVERSE RESISTANCE

Testing the forward resistance of the base/emitter junction of an npn transistor requires its base to be positive with respect to the emitter. Switching S3 to its resistance position and S5 to its base/emitter position achieves this and the meter in series with the base measures the current flow.

A large base current is not required or advisable for this test and therefore R6 is included to limit this current below 1mA. Hence the

meter does not require a shunt when making resistance measurements.

To check the junction is behaving like a diode the forward/reverse switch S2 is changed to its reverse position. This reverses the supply voltage applied to the base/emitter junction, also the meter connections.

As the diode is now reverse biased, only leakage current will flow. One can test the base/collector junction in the same manner with switch S5 in the relevant position.

Most general purpose transistors have a minimum base/emitter breakdown voltage (V_{EBO}) of 5V and as a safety measure the test voltage is set below that limit at 4.7V. The Zener diode D1 and resistors R1a and R1b achieve this and also enable the unit to function with a supply in the range of 10 to 20V.

CONSTRUCTION

The prototype unit was built in an Olsen type 25A metal instrument case with louvres, of approximate size 160×110×100mm, although any similar case will do.

With reference to Figs. 3 and 4, drill the front panel to suit the components and then fit them in position and secure.

TRANSISTOR TESTER

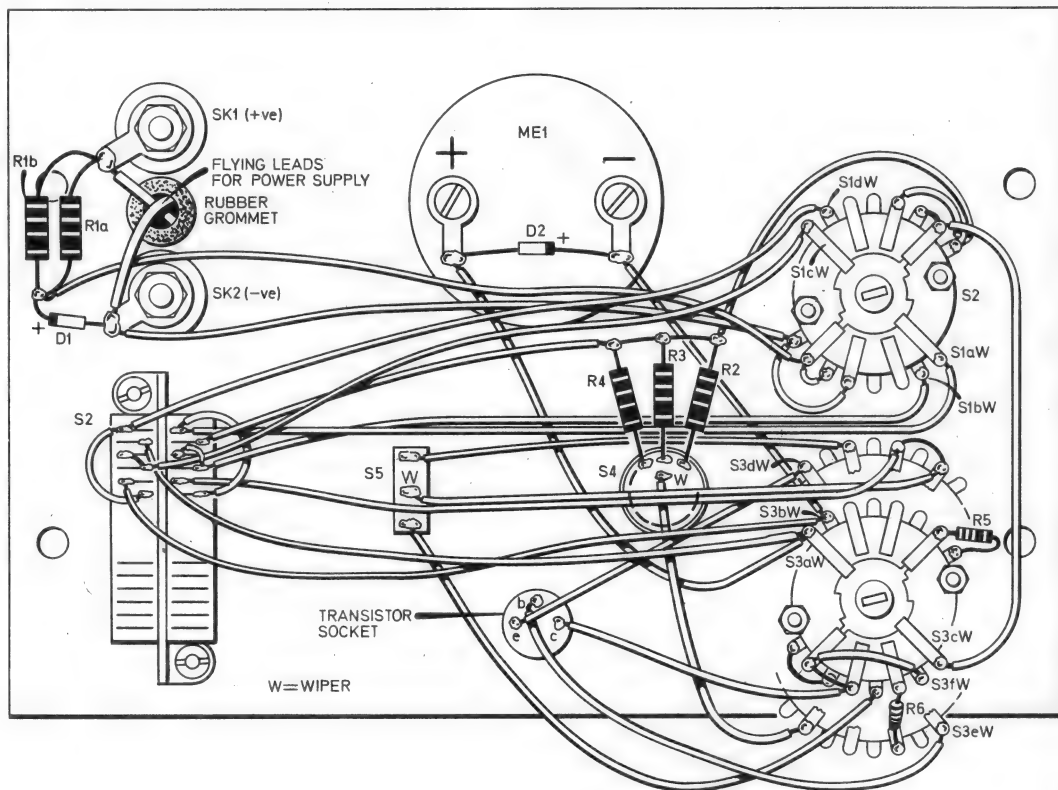
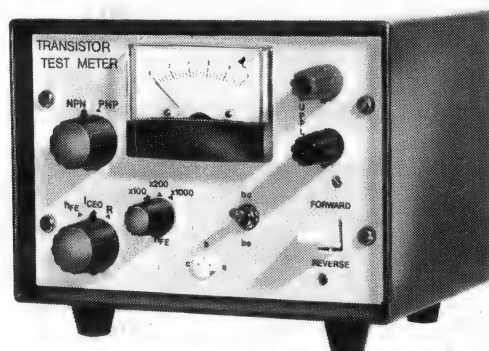
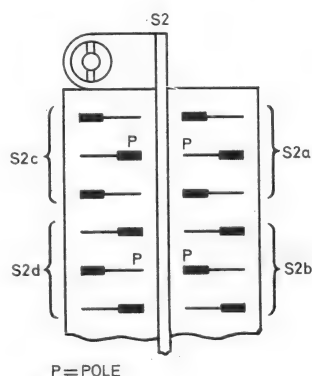


Fig. 3. The positions of the components, all of which are mounted on the front panel showing wiring details. For clarity the top half of S2 is detailed below left.



Photograph of the completed Transistor Tester.

Components....

Resistors

- R1a 680Ω ½W
- R1b 680Ω ½W
- R2 39kΩ
- R3 75kΩ
- R4 390kΩ
- R5 18Ω
- R6 6.8kΩ

All ¼ W ± 5% carbon or better, except where stated

SEE
**SHOP
TALK**

Diodes

- D1 400mW 4.7V Zener diode type BZY88 or similar
- D2 AAZ15 germanium or similar

Switches

- S1 four-pole two-way Maka
- S2 four-pole two-way biased lever type MLK03 4CN/S (Keyswitch)
- S3 six-pole three-way Maka
- S4 single-pole three-way rotary type
- S5 single-pole changeover toggle

Miscellaneous

- ME1 1mA d.c. SEW SD460
- SK1, 2 heavy duty insulated terminals (one red, one black) (2 off)
- Knobs: two large, one small with indicators (3 off); three-pin transistor socket.

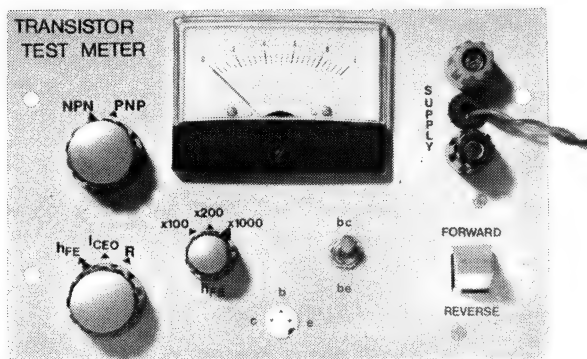


Fig. 4. Details of component positions and labelling on the front panel of the unit.

TEST PROCEDURES

Set the *npn/pnp* switch to its relevant position and place a transistor in the test socket. To check gain, position the test mode switch S3 to *h_{FE}* and the gain control to its x100 position.

If the meter indication is greater than full scale, switch the gain control until a direct reading can be taken. Multiplying this reading by the gain control position gives the *h_{FE}* of the transistor under test.

Remember that the parameter *h_{FE}* is related to collector current when testing high-power transistors, as there is a large difference between the test and normal operating collector currents.

To check that the transistor's collector leakage current is not excessive, position the test mode switch to *I_{CEO}* and check that the meter registers a small, if any, current flow. Again, if testing a high-power transistor, some of which have a high leakage current, it is advisable to refer to this particular transistor's data before dismissing it as faulty, purely on the strength of high leakage current.

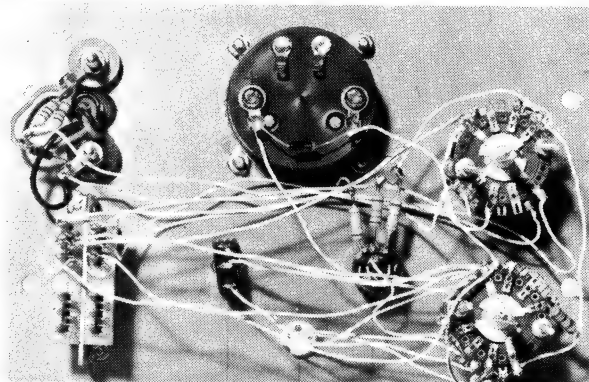
RESISTANCE

If the previous tests give incorrect results the transistor is faulty and a resistance check will confirm this. To perform the latter test, position the mode switch to resistance and the base/collector, base/emitter switch to base/emitter. Check that the meter indicates a current flow; if not the base/emitter is open circuit.

If the meter indicates a current flow, position the forward reverse switch to reverse and check that only leakage current is flowing. If the meter registers a current flow, the base/emitter junction is short circuit or acting as a resistance and not a diode.

Check the base/collector junction by the same procedure, but with the base/emitter, base/collector switch S5 in the relevant position.

The forward, reverse switch action is such that it is non-locking in the reverse position.



Photograph of completed prototype unit removed from case.

The majority of switches used (e.g. S1—3) have several poles and wiring can easily become confused. It is therefore advisable to wire according to Fig. 3 in conjunction with Fig. 2, starting at the left-hand side of the diagram and working methodically through to the right completing each switch position before going on to the next.

Another aid in clarifying this exercise is to cross off on the diagram each wire as it is connected.

When this has been done and thoroughly checked out, the front panel should be labelled as detailed in Fig. 4 and the knobs screwed on.

This is necessary as inadvertently leaving this switch in the reverse position will alter the sense of the *npn/pnp* switch. Biasing the switch in the forward position resolves this problem.

DIODE TESTING

This system can be used equally well for resistance measurements of a diode. Proceed as for a transistor measurement, but ensure that the *npn/pnp* switch is in the *npn* position and the base/emitter, base/collector switch is in the base/emitter position.

As stated earlier the base connection is now positive with respect to the emitter and therefore they can be used for the respective anode/cathode connection of the diode to be tested. Place the diode in the base and emitter connections of the transistor test socket and operate the forward, reverse switch to check the diode action.

UNKNOWN TRANSISTORS

If a transistor type or lead connections are unknown, adopt the following procedure. Posi-

tion the mode switch to resistance, and ensuring the base/emitter connection (be) has been selected, place any two of the three transistor leads in the base/emitter test points.

Using the forward and reverse switch, check to see if this connection behaves like a diode. If it does, continue the process combining other pairs of leads until a particular pair give no indication of current flow in either position of the forward reverse switch. This will indicate that these leads are the collector and emitter connections thereby proving the remaining lead is the base.

Connect the known base lead to its relevant position and with either of the remaining leads in the emitter connection, position the *npn/pnp* switch to give a meter reading. As the forward reverse switch is biased in the forward position, the *npn/pnp* switch will indicate transistor type when current flow is registered.

Finally, distinguish between collector and emitter leads by positioning the mode switch to h_{FE} and then interchanging the collector/emitter lead positions until the highest gain reading is obtained. The transistor has now been identified with respect to type and lead connections. □



...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

I HAVE often wondered what percentage of the amateur electronic enthusiasts visit exhibitions? The Boat Show is crammed with boating enthusiasts, the Motor Show with motorists and this list could be considerably extended, but I get the impression that the majority of people at an electronic exhibition are from industry or like myself connected with the trade. If I am correct I think it is a great pity.

The only exception to this was the Radio Hobbies Exhibition (now I believe, defunct) which used to be held at the Horticultural Hall, Victoria and later at Seymour Hall, Seymour Place. It was held in November and it was packed full of the amateur fraternity.

All the same we have a very fine "professional" electronics exhibition in London every year around May and smaller exhibitions are held in Leeds and Brighton. If you venture to the Continent there are large exhibitions in Berlin, Hanover and Paris.

I never miss the London ones and in the last 10 years I have

only missed the Paris one *once*. It was the fact that I have just read a notice in the press to the effect that the "Salon International des Composants Electroniques" in Paris is on, from the 1-6 April inclusive which prompted this article. This is an international exhibition and some 23 different countries are represented including of course the U.K.

I certainly urge you all (especially if you are London based) to visit one of these exhibitions. You will learn a lot, and be able to examine the most up to date circuitry in electronics, you will also find the staff on the stands most helpful. No matter that you are not placing any orders, they know that the amateur of today may be the chief buyer of a large concern tomorrow.

Paris

If you enjoy the London ones, then be extra daring and next year try Paris. Everyone ought to visit Paris once in their life, so combine two pleasures and do the Eiffel Tower, the

Louvre, and the Lido as well!

Having said all that, I would like to make a plea to have an exhibition for the **amateur electronics constructor**, including the "ham". I think the only way it will come about is if the electronics magazines themselves sponsor it!

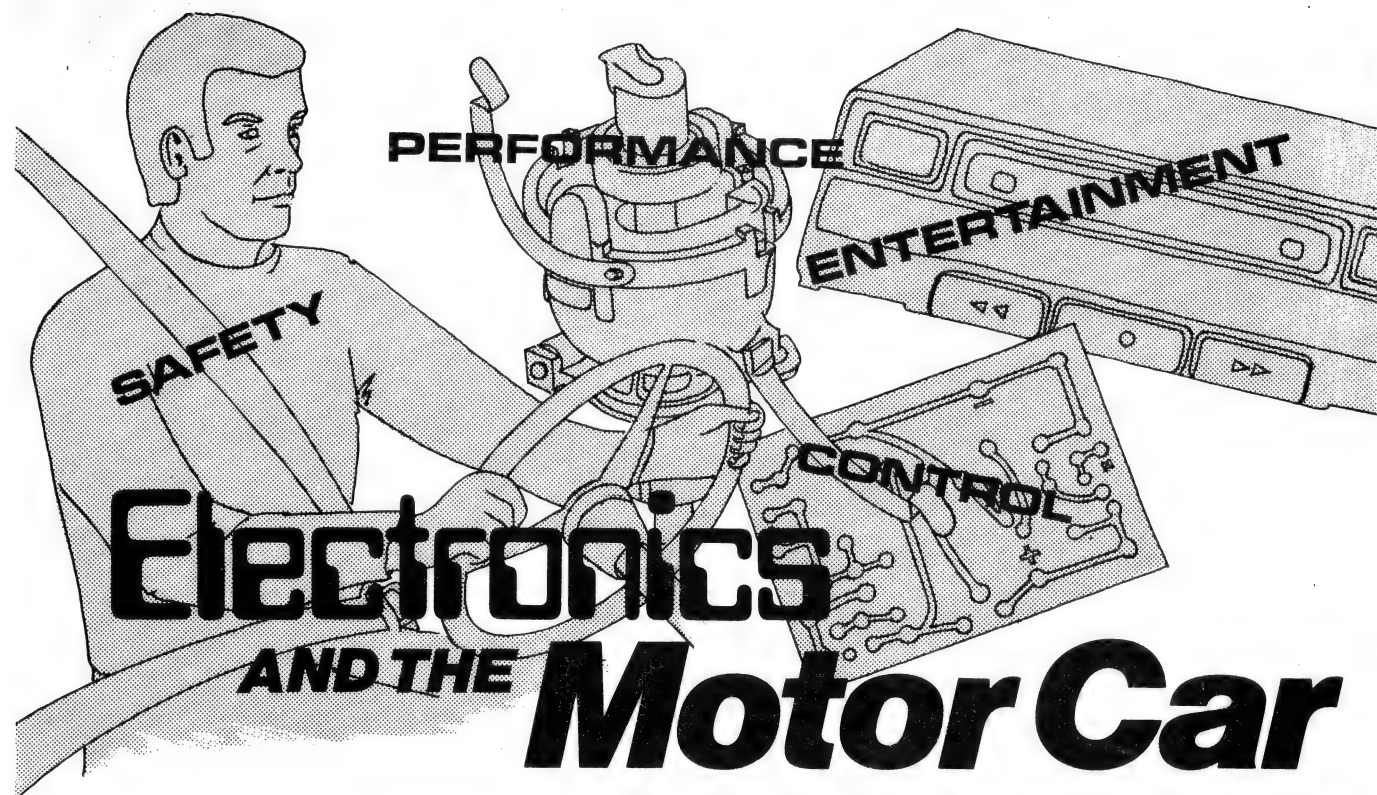
There is at Olympia, an annual "Do It Yourself" exhibition and since they don't take all the space it might be tacked on to that. I am sure we could rely on the support of many component retailers—even to the extent of taking stands.

Should any of you wish to go to either the "R.C.E.M.F." or "Electronics Instruments and Automation" Exhibition (they alternate each year) these are the two London Exhibitions and announcements should be appearing in the press in April giving the dates, or visit your reference library and have a look in "Whats On" at the exhibitions page.

With reference to the Paris exhibition for information write to:

The French Trade Exhibitions,
196 Sloane Street,
London S.W.1

or telephone 01 235 3234. You will also find the French Tourist Office in Piccadilly, London W.1 very helpful on hotels and travel facilities.



By C.S.POINTER

THE electronic content of some of the new more advanced cars now reaching the dealers' showrooms is increasing each year. Many of the more expensive cars have as standard equipment or optional extras electronically controlled fuel injection, transistorised ignition, electronic tachometer, stereo cassette player, a.m./f.m. transistor radio, etc.

This trend can be expected to continue in the future with developments such as ignition cut-out systems operated when seatbelts are not correctly worn and automatic control of vehicle speed at a pre-set value. There are many developed systems and production electronic extras available and some of these will be covered in this article.

SAFETY DEVICES AND SYSTEMS

Electronics can be used to operate such safety devices as ice warning units (to warn the driver of a temperature approaching freezing point), direction indicators, speed warning devices, automatic headlamp dipping units and emergency flasher units.

One company has developed a system to prevent a car fitted with the system being driven if the seat belts are not correctly worn. This system cuts out the ignition to prevent the car from being driven unless the driver and pas-

senger wear their seatbelts. Fig. 1 shows the system attached to a car, the system operation is as follows.

The weight of a person sitting on the seat operates a sensor in the seat Fig. 1c. The ignition circuit is then broken unless the seatbelt is correctly worn and the sensing circuit is com-

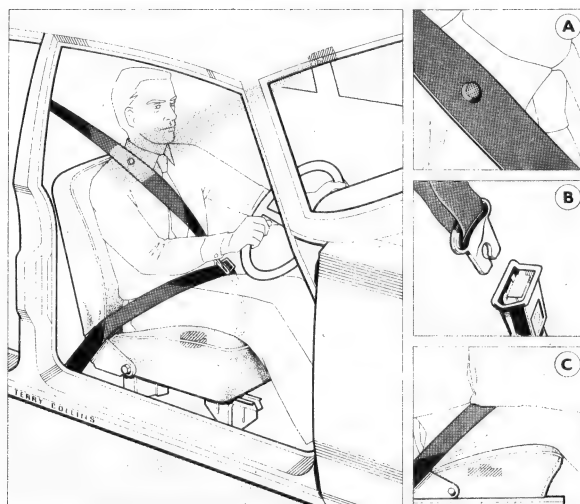


Fig. 1. The seat belt system developed by Mul-lard and the Ford Motor Company.

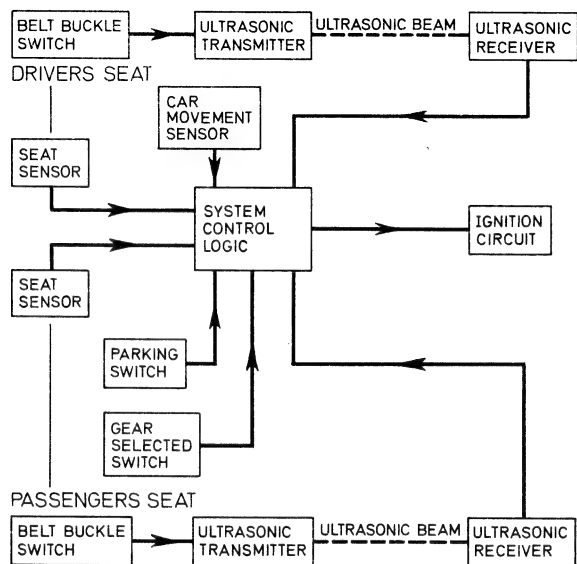


Fig. 2. Control logic of the system shown in Fig. 1.

plete. When the belt buckle Fig. 1b is closed, an ultrasonic transmitter mounted above the car windscreen emits a signal. If the belt is correctly worn across the driver's body then the ultrasonic signal beam will be picked up by an ultrasonic receiver on the belt, Fig. 1a, the signal at the receiver completes the sensing circuit and then the system logic closes the ignition circuit enabling the car to be driven.

The system has been designed to filter out short term interference from such things as cigarette smoke or quick hand movements across the ultrasonic beam. A delayed action and possibly some warning of pending ignition cut-out would be required in the event of the seatbelt being removed whilst the vehicle was in motion.

The system control logic can be arranged so that the car can be parked or garaged in low gear or reverse without the need for the seatbelt to be worn by the driver. The block diagram, Fig. 2, shows a system with the facility for overriding control for parking as mentioned above.

The passenger seat sensor provides a signal to the system control logic if the passenger seat is occupied, the ignition circuit is then broken unless both seatbelts are correctly used. The delayed action and warning lamp control circuits would be built into the system control logic circuit, the warning lamp being flashed on and off to attract the driver's attention.

There are many safety systems which have been developed in the last few years, these include an experimental radar unit to give the driver warning of obstructions or vehicles ahead of his car in foggy conditions, there are also several anti-lock braking systems.

Anti-lock braking systems have been developed to prevent any one or all of the wheels of the

car from locking and putting the car into a skid. A set of wheel sensors detect the onset of wheel lock and transmit a signal to the control unit which varies the operating pressure of a pressure limiting valve in the hydraulic brake line to the wheel brake cylinder, Fig. 3.

PERFORMANCE AND PERFORMANCE MEASUREMENT

There are two fields in which electronics can be used in connection with performance, the first production of performance, the second measurement of performance.

The two main types of electronic unit used in performance production are transistorised ignition systems and electronically controlled fuel injection systems.

Transistorised ignition systems fall into two types, transistor assisted ignition and capacitor discharge ignition. Transistor assisted ignition systems use a transistor amplifier switched by the contact breaker points to switch on and off a high voltage power transistor in the ignition coil primary circuit; since the transistor amplifier input current is small, and non-inductive arcing at the contact breaker points is virtually totally eliminated, point wear is greatly reduced; with the use of a high ratio ignition coil the ignition h.t. voltage is increased, raising ignition efficiency. This system can be used with contact breakerless ignition systems where the transistor amplifier is switched by a magnetic pickup in the distributor.

Fig. 4 shows the block diagram of a transistor assisted ignition system using a magnetic pickup in place of the conventional contact breaker. An oscillator in the amplifier unit connected to the

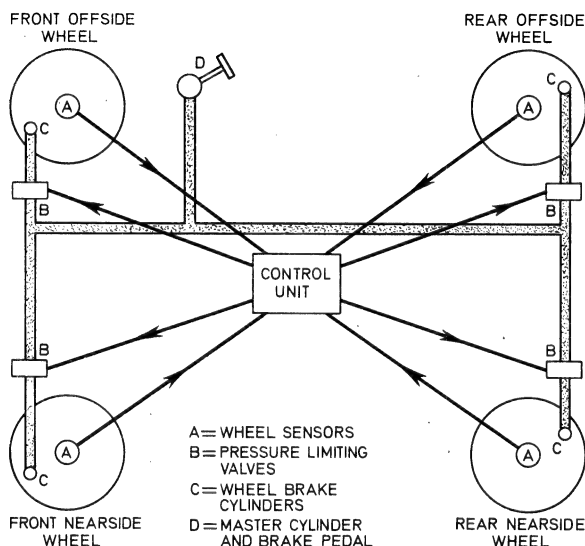


Fig. 3. Block diagram of an antilock braking system for vehicles.

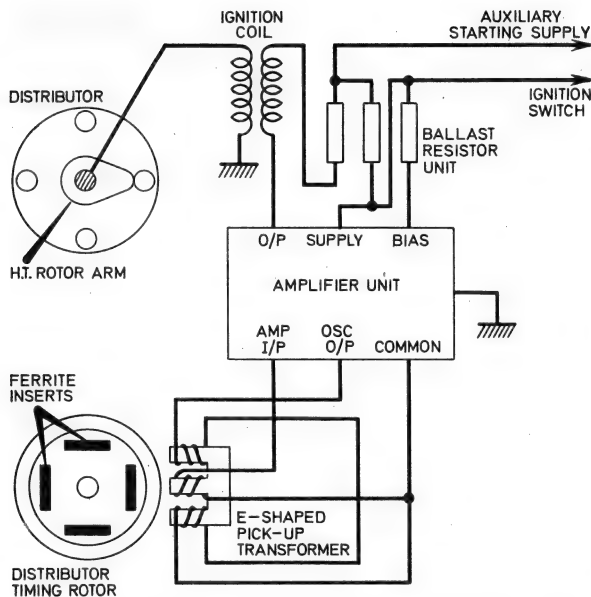
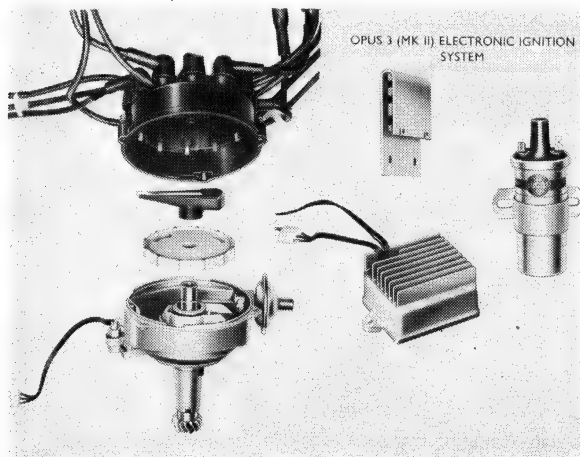


Fig. 4. A transistor assisted ignition system using a magnetic pickup.

pickup supplies a signal voltage to the input windings wound on the outer limbs of the "E" shaped pick-up transformer.

The signal voltage sets up a field around each outer limb, the two fields oppose one another and the magnetic fluxes produced in the centre limb are arranged to cancel, therefore the voltage induced in the output winding wound around the centre limb is very small.

When one of the timing rotor ferrite inserts passes the pick-up transformer, bridging the gap between one of the outer limbs and the centre limb of the transformer, the magnetic fields no longer cancel and the resulting flux induces a voltage in the output winding of the pick-up. The output from the pick-up is fed to the amplifier unit and the presence of a signal resulting



The Lucas Opus 3 (Mk I) ignition system using a magnetic pickup.

Everyday Electronics, May 1974

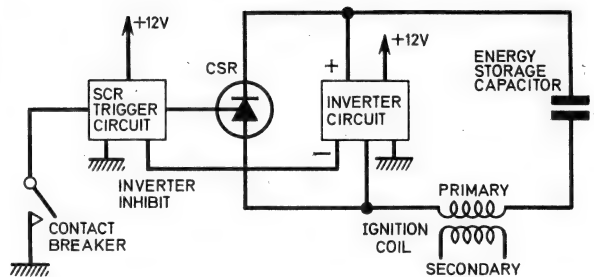


Fig. 5. A block diagram of a capacitor discharge ignition system.

from the ferrite insert lining up with the pick-up turns off the normally conducting power output transistor in the ignition coil primary circuit.

When the power output transistor turns off the current flow to the ignition coil, a large voltage is induced in the coil secondary, the h.t. voltage produced is switched to the appropriate sparking plug by the distributor h.t. rotor and ignition occurs.

Control of ignition timing with vacuum and centrifugal advance can be incorporated in this system by vacuum control of pick-up module position and centrifugal control of timing rotor position. The ballast resistor unit provides bias to the power transistor and also increased ignition coil voltage for cold starting.

This system requires much less maintenance than conventional ignition systems, and will operate efficiently at much higher engine speeds. Since this system is unlikely to go out of adjustment, correct timing is maintained resulting in more control of exhaust emission, fuel economy and constant performance.

Shown in Fig. 5 is the block diagram of a capacitor discharge ignition system. The inverter circuit running at about two thousand cycles per second and rectified by a high voltage bridge, charges the energy storage capacitor to a high voltage (approximately 500 volts).

When the contact breaker points close, the trigger circuit switches on the silicon control rectifier and the storage capacitor is connected across the ignition coil primary. The energy stored in the capacitor causes the coil primary voltage to reach, very quickly, a large negative voltage; the capacitor then discharges and the current in the coil primary passes through zero cutting off the thyristor.

The fast change in the coil primary induces a large voltage in the secondary which supplies h.t. to the plugs via the distributor head rotor arm.

This system will operate more efficiently than normal systems even with fouled plugs and gives easier starting with smoother running from cold. A standard ignition coil can be used since a high ratio coil is not required as used with transistor assisted ignition circuits.

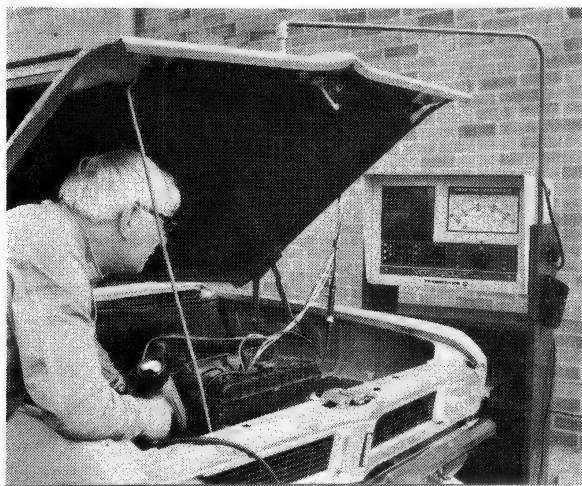
Electronic fuel injection systems are now used on some production cars. One of the units used

contains a plug-in printed circuit board plus power transistors mounted on a suitable heat-sink. The unit monitors engine temperature and inlet manifold pressure and operates the fuel injectors to deliver the correct amount of fuel for the operating conditions. Since the amount of fuel delivered is controlled, the efficiency of the engine may be increased, and fuel economy together with pollution control may be achieved.

DIAGNOSIS

Separate measuring instruments are mainly used for setting up and checking that the car is properly tuned. Many garages have electronic tuning aids for measuring ignition settings and performance, battery charging circuit efficiency and engine performance. These instruments range from those displaying the measured performance on a meter to those displaying waveforms on a screen or giving a digital display or printout.

With the use of an oscilloscope display unit, it is possible to monitor the ignition system performance with the engine running. By displaying on the screen the ignition coil primary



The Crypton "Motorscope" Mk VI engine analyser shown in use.

voltage waveform, diagnosis can be made of damaged plugs and fouled plugs, open-circuit h.t. cables, etc. The complete waveform for all the engine cylinders can be displayed and the faulty components associated with a particular cylinder can be pinpointed.

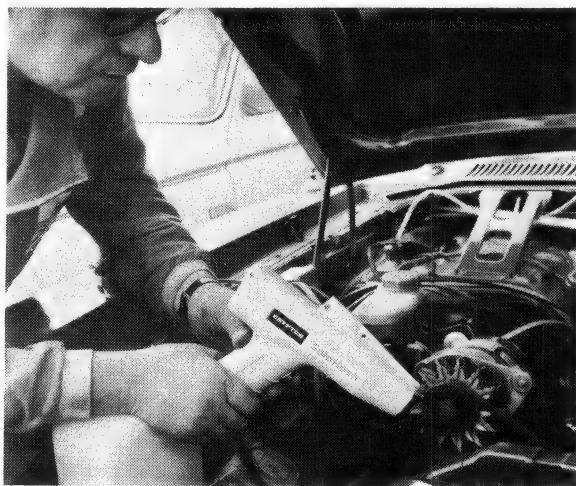
A network of dealers are now using a diagnosis system to check customers' cars; all new cars sold by the dealer network being fitted with sockets for connection to the diagnosis equipment, older models not fitted with sockets are connected to the equipment via adaptor leads. For each model to have diagnosis service a programme card supplies data to the diagnosis equipment controlling the tests carried out and giving the correct readings that should be

obtained for comparison, within the equipment.

After connection of the equipment to the car and programming the unit using the correct card, a digital display indicates the number of the test to be carried out and the value measured then appears on the digital display. If the measured value is within the specified limits the measured value is printed out on the test record which is presented to the customer at the end of the tests. Those operations and tests which are not automatically carried out are completed by the mechanic using a manual input unit.

The diagnosis covers steering, brakes, electrical equipment, tyre pressures, oil, brake-fluid, water levels, engine cylinder compression and engine dynamic tests. One test automatically carried out is measurement of wheel alignment which is measured by reflecting a projected light beam across a measuring plate; another check is to measure the battery fluid using a sensor mounted in the battery.

Using this system allows a mechanic to check 88 test operations in about half an hour. The police also use electronics to check the speed of vehicles on the road using the Doppler effect



A Crypton timing light being used to set the ignition timing with the engine running.

to measure the speed of a car passing the radar unit.

The most widely used electronic instrument for measuring performance fitted to today's cars is the electronic tachometer unit; this device converts the pulses produced by the ignition circuit contact breaker points into meter deflection current, thus giving a meter reading proportional to the engine speed. The input to some tachometer units is taken from an input sensor which consists of a coil of a small number of turns wound around the contact breaker to coil connection wire.

Next month. This article will be continued and will cover car security, entertainment and communication.



BOTH our series of constructional projects concerning test gear (the *E.E. Test Gear Five*), which will finish next month when the *R.F. Signal Generator* is published, and last month's special supplement *Test Gear* may have aroused some interest in many constructors.

The section on multirange meters in the supplement started by saying: "A multirange test meter is probably the first and most useful item of test gear anyone is likely to purchase." This is, of course, quite true and if you do not have any test gear you should look at meters before anything else.

To get a worthwhile instrument you will probably have to spend about £8 or more. However, next month we are presenting an exciting opportunity for you to win a multimeter. A number of good quality meters will be presented as prizes in our free entry competition, so don't miss this chance.

Transistor Tester

One or two problems concerning components for the *Transistor Tester* may arise, mainly with the switches specified. The miniature Maka switches should be generally available—if you have trouble one of the larger London based suppliers should be able to help. You will probably have to buy the parts separately and assemble them. The wafers used on the prototype were two 4 pole, 3 way (used for the 6 pole 3 way

switch) and one 4 pole, 3 way (used for the 4 pole, 2 way switch).

Obviously 2 poles are not used on the first switch and one "way" is not used on the second. The switch assembly has a "stop washer" which can be adjusted so that the switch will rotate only through the required number of positions.

The lever key switch is available from Farnell Electronic Components Ltd., Canal Road, Leeds, LS12 2TU. The switch is type MLK03 4CN/S and will only move in one direction, without locking. It will only have contacts on one side as shown in the wiring diagram. The switch costs 78p plus 3p for the handle plus 25p small order surcharge plus VAT—we make that about £1.17. Handles are available in a vast range of colours, red, dark green, blue, yellow, grey, ivory, maroon and black being the main ones—state colour required when ordering.

Electronic Bagpipes

Once again the problems with parts for the *Electronic Bagpipes* article seem to be confined to switches. This time very simple, small **press to break** switches which are available from a few of the larger suppliers. The switches should be miniature types—not exceeding about 35mm overall and must be **press to break**.

The microswitch used for the on/off switch must be capable of

being operated when the side is squeezed and is best if it can be screwed to one side and operated by the other. Most types with a button operator are suitable.

Chanter material will depend on what is available but make sure the switches will go inside—the connection tags may need bending over for this. Most other parts should be readily available.

Egg Timer

All parts for the *Egg Timer* should be generally available, although you may have to shop around a bit for the loudspeaker. The case used in the prototype came from Trampus Electronics, PO Box 29, Bracknell, Berks, but quite a few similar types are available from many suppliers.

Simple Buzzer

The *Simple Buzzer* is built around a balanced armature ear-piece. The most important things to check when buying this is that the impedance is correct and that the whole thing can be taken apart. For this reason one of the ex. W.D. types in a plastic case will probably be best.

Stop Press!

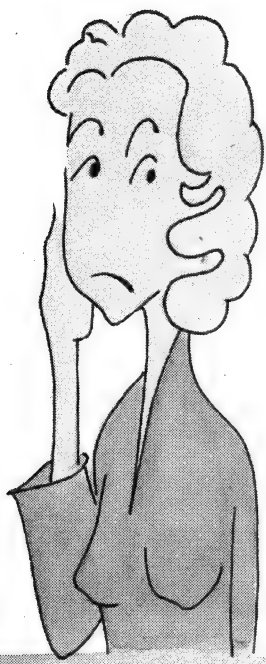
The twin ganged potentiometer for the *Audio Frequency Oscillator* (March 1974) is available from Radio and T.V. Components Ltd., for a total cost of 75p including postage, packing and VAT.

PLEASE TAKE NOTE

In the *Electronic Voltmeter* article last month, Fig. 3 (page 28) some of the resistor numbers are shown incorrectly. The following alterations should be made to the drawing: R12 becomes R10, R8 becomes R7, R5 becomes R4, R10 becomes R8, the unmarked resistor is R5

In *Demo Circuits* last month (page 221) the formulae for inductive reactance and capacitive reactance are shown under the wrong headings, they should be transposed.

In *Teach-In '74* Lesson 6, Fig. 6.3. The wire from B2+ve should go to the centre tag of S1. Lead from D2+ve should go to junction of R3/B1-ve.



... WELL! MAKE THE E.E EGG TIMER!

By R.A. PENFOLD



This device can ensure that your egg is cooked to the same, required constituency, every time.

THE device to be described here is a timer which gives an audible warning when the set time interval has elapsed. Although designed specifically as an egg timer, it can be used for any application requiring an audible alarm output after up to five minutes (approx.).

This simple device is quite compact and it is completely self contained. Power is obtained from an internal 9 volt battery.

Being a piece of household equipment, it must of course be easy to operate. There are only two controls, one being a dial on which the required period of time is set (this is continuously variable from 2 to 5 minutes), and the other is the on/off switch.

When the desired time has been set on the dial, the unit is turned on, and then left. When the set time has elapsed, an audible warning (a howling noise) is produced by the timer. This will continue until the unit is turned off, whereupon it is ready for use again.

The unit is not only suitable for use as an egg timer, but can be used on any process taking a similar time, providing a high degree of accuracy is not required.

BASIC OPERATION

There are really three separate circuits which comprise the timer, bistable and oscillator, and Fig. 1 shows these three stages, and the output waveform of each in block diagram form.

The first stage is the timing part of the circuit, and this produces a short, positive electrical

pulse at the end of the timing period. This pulse is used to trigger the second stage of the unit, and this is a bistable multivibrator, which is sometimes just termed a "latch", for reasons which should become obvious.

The latch is required in order to turn the short output pulse from the timer circuit, into a continuous positive output, which is used to operate the third stage. This is an audio oscillator which feeds a loudspeaker. Thus the short pulse from the timer circuit will cause a continuous tone from the loudspeaker which will persist until the unit is turned off.

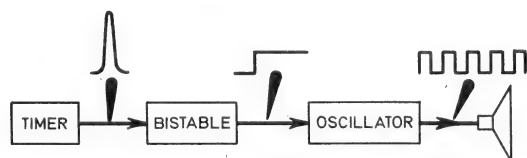
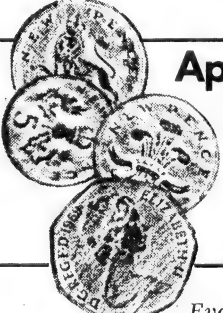


Fig. 1. The block diagram of the Egg Timer.



**Approximate cost
of components
including V.A.T.**

£2.35

excluding case

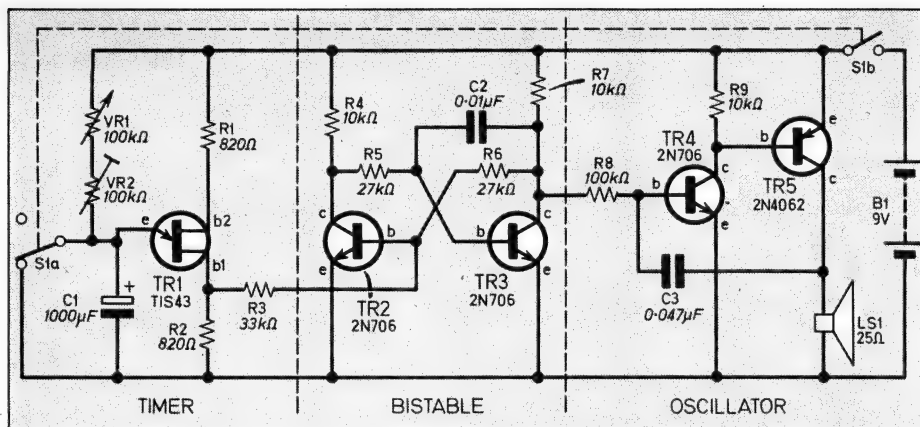


Fig. 2. The complete circuit diagram of the Egg Timer showing the three major sections.

THE CIRCUIT

A complete circuit diagram of the Egg Timer is shown in Fig. 2; dotted lines break the circuit into the three sections outlined above.

Transistor TR1 is a unijunction transistor, and the operation of this is completely different to that of an ordinary transistor. The unijunction has an emitter, two bases, and no collector. With no voltage present at the emitter terminal, the base 1 and base 2 connections of the transistor will have the characteristic of a resistor with a value of a few kilohms between them.

With reference to Fig. 2, with S1 in the on position, there will be a potential of about one volt at TR1 base 1. The input resistance to the emitter of TR1 will be extremely high at low voltages, perhaps several hundred megohms, therefore C1 will begin to slowly charge through VR1 and VR2.

Since C1, VR1 and VR2 all have high values, the voltage across C1 will increase slowly.

Eventually, when there is a potential of a few volts across C1, the triggering point of TR1 will be reached. When this happens, the input resistance to the emitter of TR1 drops to a very low level, and C1 will discharge very rapidly. As this occurs, the resistance between TR1, base 1 and base 2 will drop to about half its previous level, thus causing the voltage at base 1 to rise to about 4 volts. This will only last for the time it takes for C1 to discharge (a fraction of a second), and then the circuit returns to the beginning of the cycle.

Both VR1 and VR2 can alter the time taken between turn on, and the pulse at TR1 base 1. Potentiometer VR2 is a preset type connected as a variable resistor which is adjusted so that VR1 (which is fitted on the front panel of the timer, and has the dial marked around it) covers the required range of 2 to 5 minutes. Component VR2 has to be a preset, rather than a fixed resistor, so that compensation for the wide tolerances of the electrolytic capacitor used for C1, can be made. The tolerance of this component can be as much as plus 100 per cent and minus 50 per cent.

BISTABLE MULTIVIBRATOR

Transistors TR2 and TR3 form the bistable. When the supply is turned on, the voltage at the collector of each transistor will begin to rise. Due to the component tolerances, the voltage at one collector will rise more quickly than that at the other collector. To ensure that the voltage rises more quickly at the collector of TR2, C2 has been included.

As the voltage at TR3 collector rises, this rise will be coupled by C2 to TR3 base, where it will have the effect of reducing the voltage at TR3 collector. The effect of C2 is only slight, but is enough to ensure correct circuit action.

The voltage at TR2 collector will therefore rise quickly to almost the full supply potential, and this will be coupled through R5 to TR3 base, causing the potential at TR3 collector to go to almost zero. Thus each time the unit is switched on, TR2 will be off (not conducting) and TR3 will be fully on (conducting).

Base 1 of TR1, and the base of TR2 are coupled by R3. Therefore, when base 1 goes positive at the end of the timing period, TR2 base will also go positive. This will cause TR2 collector to go more negative. Because the collectors, and bases of TR2, and TR3 are cross coupled by R5 and R6, a regenerative action will take place. The base of TR3 will go more negative, causing TR3 collector to go more positive, bringing us full circle back to TR2 base which will go still more positive. This regenerative action will continue until the transistors have changed states, with TR3 collector at nearly full supply potential, and TR2 collector at almost earth potential. In other words TR2 is fully on and TR3 fully off.

It is seen from this that the bistable will have only a small output voltage until it is triggered by the short output pulse from TR1, whereupon its output will rapidly swing to a high level, and stay at this level.

AUDIO OSCILLATOR

The audio oscillator is formed by TR4, and TR5. These are both operated as common emitter amplifiers, R9 being the collector load

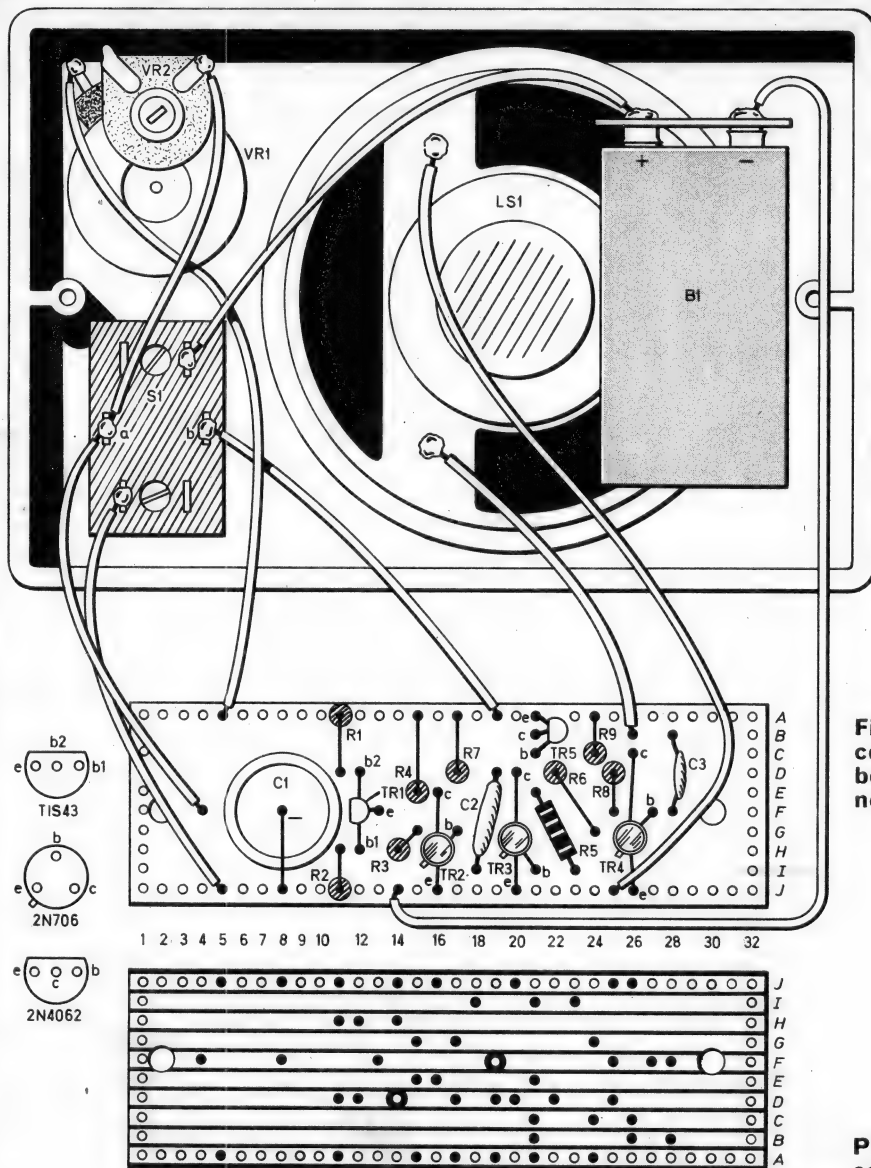
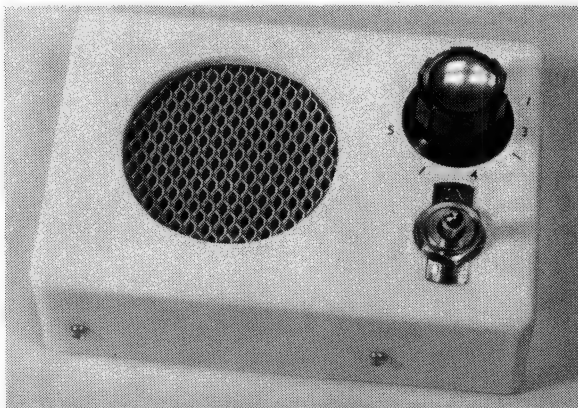


Fig. 3. The layout of the components on the Vero-board wired to the components mounted in the case.

Photograph showing the completed Egg Timer.

EGG TIMER



Components....

Resistors

R1	820 Ω
R2	820 Ω
R3	33k Ω
R4	10k Ω
R5	27k Ω
R6	27k Ω
R7	10k Ω
R8	100k Ω
R9	10k Ω

All $\frac{1}{4}$ W carbon $\pm 10\%$

Capacitors

C1	1000 μ F elect. 10V
C2	0.01 μ F
C3	0.047 μ F

Semiconductors

TR1	TIS43 unijunction
TR2, 3, 4	2N706 silicon <i>n</i> p <i>n</i> (3 off)
TR5	2N4062 silicon <i>p</i> n <i>p</i>

Miscellaneous

VR1	100k Ω carbon lin.
VR2	100k Ω preset lin.
S1	double-pole double throw toggle or slide switch
LS1	25 ohm loudspeaker approx. 70mm diameter
B1	9 volt PP3

Veroboard, 0.1in. matrix size 10 strips by 32 holes; speaker fret; connectors to suit B1; plastic case size 110 x 72 x 30mm or larger; knob.

SEE
**SHOP
TALK**

and then drill the two fixing holes for 6BA clearance (No. 31 twist drill). Now position and solder all the resistors and capacitors in place as detailed and then position and solder the transistors in place using a heatshunt to avoid thermal damage.

The prototype Egg Timer was housed in a commercially available plastic case, size 110 \times 72 \times 30mm (internal dimensions). Any case of similar size is equally suitable but do not choose one that is any smaller than employed on the prototype otherwise it may be impossible to fit all the components into it.

Should a metal case be used, steps must be taken to insulate the Veroboard panel from this, and it should be ensured that no other parts are in electrical contact with it.

Make the necessary cut-outs and holes in the case to suit the components and board fixings and then secure the remaining components in position as indicated in Fig. 3.

A cut out about 50mm in diameter should be made in the front of the case, where the loudspeaker is to fit, and a piece of speaker fret glued to the inside of the case to cover the hole. The speaker is then glued to this.

As can be seen, the preset potentiometer VR2 is soldered directly to VR1. Either a horizontal or a vertical mounting type can be used, but in either case it should be orientated so that it can be easily adjusted when soldered in place. Now wire up according to Fig. 3 and when completed fix the board to the inside of the case as shown in Fig. 4.

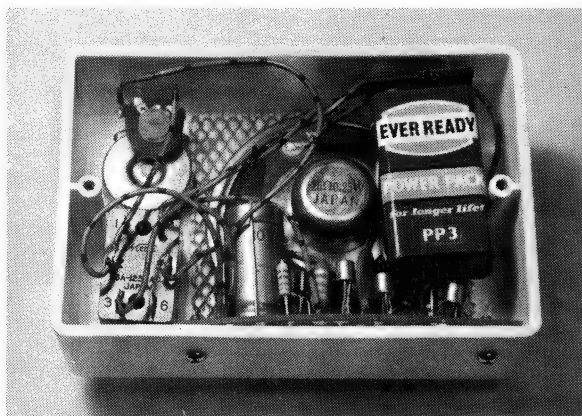


Fig. 4. The completed unit with lid removed.

No battery bracket is detailed as this was found unnecessary; a piece of foam rubber below and above the battery will hold it securely in position when the lid is screwed on.

ADJUSTMENT AND CALIBRATION

The only adjustment required is that of VR1. This should be set with the slider half way around the track at the outset; VR2 is adjusted

resistor for TR4, and LS1 is the collector load for TR5. The input, and the output of the circuit are in phase, and C3 will therefore introduce positive feedback, which will cause the circuit to oscillate when a suitable biasing current is present at TR4 base.

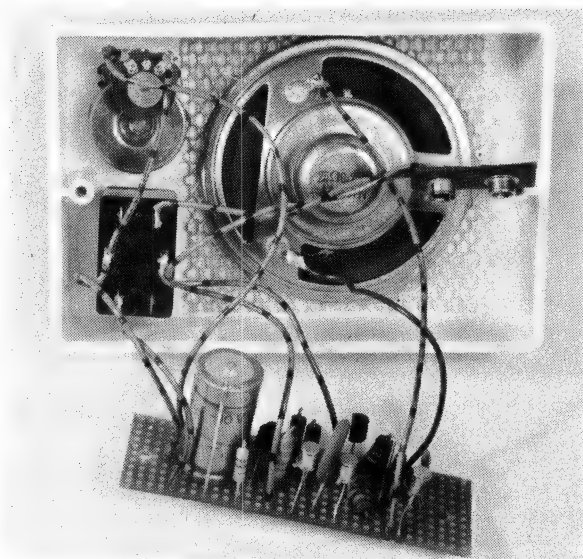
However, the biasing resistor, R8, is connected to the output of the bistable, and will normally be at a very low potential, and will not introduce a proper biasing current. At the end of the timing period when the output of the bistable changes to a higher potential, then the required biasing current is introduced, and the circuit will then oscillate, producing an audible tone from LS1.

When the circuit is turned off, S1a shorts across the terminals of C1, ensuring that this is fully discharged, and that the unit is immediately ready for use again.

CONSTRUCTION

Most of the components are mounted on piece of 0.1in. matrix Veroboard size 10 strips by 32 holes as shown in Fig. 3. All the components with the exception of R5 are mounted vertically.

Begin construction by making the breaks along the copper strips on the underside of the board



Photograph of the completed unit with battery and board removed.

for minimum resistance (turned fully anti-clockwise), and the unit is turned on.

If it is functioning correctly, after about two minutes the alarm will sound. The exact time taken should be monitored. If it takes less than two minutes, the resistance of VR1 must be increased, and if it takes more than two minutes, the resistance of VR1 must be decreased. The

process should then be repeated until it takes two minutes (plus or minus a few seconds) for the alarm to sound, from when the timer is turned on.

It is then necessary to calibrate a scale around the control knob of VR2. The two minute has already been found, and now every half minute point up to five minutes must be found, by trial, and error. This is a lengthy business, but there is unfortunately no short cut to this. □



Ruminations

By Sensor

A Woman's Work

I suppose that those people unacquainted with the electronics industry tend, when thinking of it, to give it a masculine image—serious looking men with slide rules in their top pocket, scribbling abstruse calculations and speaking to each other in a near incomprehensible jargon. But, while men like these undoubtedly exist, for they are the visionaries and the innovators without whom the industry would soon stagnate, women dominate the scene to a remarkable extent.

In some branches of the industry women make up 95 per cent of the workforce and their jobs range from assembly work (of all degrees of complexity) through planning, drawing office,

laboratories and inspection and testing right through to senior management level.

Women, of course, also occupy the secretarial and clerical positions. I knew two young women who gave up secretarial jobs in order to work on the bench, both felt that bench work was much more satisfying than their former jobs and enabled them to employ themselves creatively. Although working conditions were not as good, and the hours worked a little longer than those they enjoyed formerly, they had no regrets about their change of occupation.

As You Like It

I once asked a woman who was doing a minor repetition job, how she could do the same thing day after day without becoming bored beyond endurance. She replied that she enjoyed the work because it left her mind free to think of other things! I have since found this to be a useful way of approaching one's own

chores. We all have boring work to do at times, and if we let our hands work automatically we can daydream, think or plan to our hearts content; thus viewed, a monotonous task can be a welcome respite from more demanding employment.

Many of the jobs done by women in the electronics and electrical industries are very demanding indeed and require a high degree of skill. I am thinking, particularly, of some of the soldering work such as soldering the "hair" springs on to a microammeter—a steady hand and a good eye together with a great deal of patience, are essential; I know—I've tried it myself.

Look around your home and you will see the work of our womenfolk—the electricity meter, the light bulbs and electrical fittings, even the wire that connects them together, the T.V., radio and all the domestic appliances were built or made almost entirely by women. And when you reach for the telephone you are touching a woman's work again.

SEMICONDUCTOR PRIMER

By A. P. STEPHENSON

11 ■ IMPORTANT TRANSISTOR CURVES

Graphs showing the effect of base current and collector voltage on the collector current.

Although collector current is very sensitive to base current, it is hardly affected by collector voltage. The graphs in Figs. 11.1 and 11.2 illustrate.

Note

If base current is increased, the collector current also increases by a much greater amount.

The ratio $\left(\frac{\text{base current}}{\text{collector current}} \right)$ is called the forward current gain h_{FE} . In Fig. 11.1, for example, $h_{FE} = 100$.

Note

Unlike the base, the collector voltage is unable to change the collector current by any appreciable amount (except for very low voltages).

As far as collector voltage is concerned, the transistor behaves almost as a constant current device see Fig 11.2.

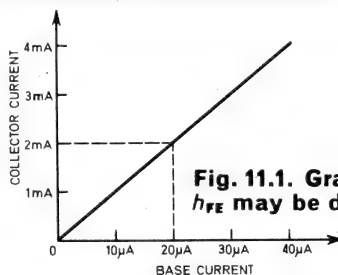


Fig. 11.1. Graph from which h_{FE} may be determined.

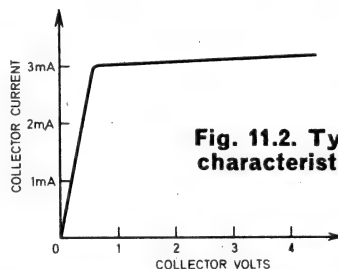


Fig. 11.2. Typical collector characteristics.

12 ■ BC107, BC108, BC109 TRANSISTORS

These form a useful trio for general audio or video circuitry and have the advantage of cheapness (about 10p each) and easy availability in almost any district.

They are silicon *npn*, planar epitaxial transistors encased in TO-18 form. BC107 is a higher voltage version, quite suitable as a driver for

audio output stages.

BC108 is a general purpose "dogsbody".

BC109 is a low noise version, particularly suitable as an input stage for low level signals.

For military use, they arrive disguised as:

CV 0374882
(BC107)

CV 0375395
(BC108)

CV 0375627
(BC109)

BRIEF SPECIFICATION

PARAMETER	BC107	BC108	BC109	UNITS
$V_{CE \text{ max.}}$	50	30	30	V
$I_C \text{ max.}$	200	200	200	mA
Power dissipation max at $<25^\circ\text{C}$	300	300	300	mW
$T_J \text{ max.}$	175	175	175	deg. C
h_{FE} (at $I_C = 10\mu\text{A}$, $V_{CE} = 5\text{V}$) (at $I_C = 2\text{mA}$, $V_{CE} = 5\text{V}$)	90 180	150 300	270 500	typical
h_{fe} (at $I_C = 2\text{mA}$, $V_{CE} = 5\text{V}$) measured at 1kHz	125 500	125 500	240 900	minimum maximum
f_T (at $I_C = 10\text{mA}$, $V_{CE} = 5\text{V}$)	300	300	300	MHz
V_{CE} saturation voltage when $\frac{I_B}{I_C} = 20$	300	300	300	mV
NOISE at $I_C = 200\mu\text{A}$, $R_s = 2\text{k}\Omega$ (max) at 1kHz B = 200Hz	10	10	4	dB



Interference

I want to fit a radio in my car. How do I go about suppressing the engine?

The main sources of interference are from the sparking plugs, the generator brushes and the coil. To overcome the loud clicking type of interference from the plugs you must suppress the leads from the distributor to the plugs. Modern cars are usually fitted with carbon leads that are already suppressed and in those cases you need not worry (in fact you will degrade your engine's performance if you try to insert suppressors). You can buy plug suppressors which are in the shape of plug caps; these screw into the cables running from the distributor—all they consist of are high value resistors that go in series with the normal plug lead.

To cure coil interference—which again is a clicking noise—connect a $0.1\mu\text{F}$ capacitor between the coil's connection to the contact breaker and ground (the car's chassis). Noise from the generator is a loud whine that rises and falls in pitch as you rev the engine. Again connect a $0.1\mu\text{F}$ capacitor between the generator's main output connection and ground—the main connection of the generator is usually the larger terminal. Do not connect the capacitor between the field coil terminal and ground.

Should interference still persist tighten up the battery connections, check the aerial is properly fitted to the radio and make sure the

aerial lead's screening is well connected to the car's chassis at the aerial end. Worn cut-out contacts can produce spurious interference which is difficult to identify. The $0.1\mu\text{F}$ capacitors we mention can be purchased from any auto spares shop and usually have the correct sized terminals to make fitting easy.

Hum Loop

Someone told me it is good practice to earth a hi fi system—not only for safety reasons but to remove hum. My amplifier was earthed but I had a bit of hum so I earthed the record player only to find the hum got worse. Is there any logical reason for this?

It sounds as though by earthing the record player you have introduced what is called "an earth loop". This is very easy to do and is often a very bad source of hum. Certainly your system should be earthed, but the connection back to the main earthing point (in your case we suspect this was the mains plug) should be by one route only. By connecting separate earths (a) from the amplifier and (b) from the turntable unit to separate (?) mains plugs you form an inductive loop (from the mains earth through the chassis of your amplifier, down the coaxial screening, through the chassis of your turntable and back to mains ground).

If you are unfortunate and have a transformer or similar inductor in the system carrying 50Hz mains the earth loop will pick up currents by induction from the source and this signal is superimposed on your pick up signal giving rise to the worsening hum. It is better to earth the amplifier and make sure that the screening of your pick up cable is grounded to the amplifier's chassis at one end and to the turntable unit's chassis at the other. This way the whole system is earthed but you do not introduce any loops.

Battery Leakage

My electronic flash gun runs off dry batteries and unfortunately these leaked and made a mess inside. However I cleaned out the battery compartment but it still won't work. Could the material from the batteries have caused any problem

or is it more likely to be something else?

Almost certainly the material from the battery is the cause of the malfunction. You must check the circuitry inside the gun and remove all traces of the paste. It can cause leakage across capacitors, bridge gaps in printed circuit boards and worse still will actually dissolve the copper from circuit boards. If you see green deposits on the copper wiring of the circuit you can bet that the last has occurred and you may have to do a bit of re-wiring.

If you do attempt to have a go yourself be warned; very high voltages at high currents are present in electronic flash guns—do not be deceived by the small batteries! So, be careful if you test it out when it is not in its case; in particular do not touch the terminals of the main capacitor unless you have discharged it first with an insulated handled screwdriver!

Transistor Selection

Your instructional articles always make the operation of a transistor seem very simple and it seems that the only parameter of importance is the h_{fe} . Is this true, and if so why are there so many different types?

It is true that h_{fe} is a very important parameter but there are other obvious ones that are just as critical. There are also a few less obvious ones. One has to consider the reverse breakdown voltage across the base/collector and base/emitter junctions— V_{cbo} and V_{ebo} ; also the breakdown voltage between collector and emitter (V_{ceo}). There is always a limit to the collector current you can draw through the device before it fuses internally (I_{cmax}).

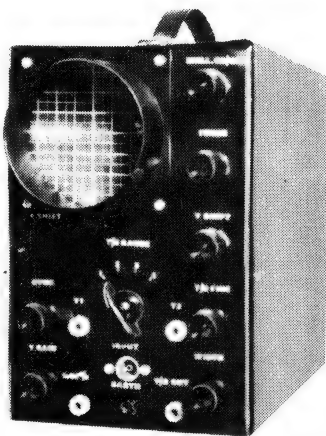
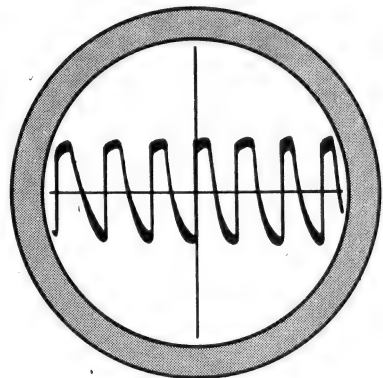
A transistor cannot dissipate unlimited power without overheating. Too high an operating temperature changes the base emitter forward voltage drop and this effects the biasing conditions. There is thus a complicated link between power dissipation and operating characteristic—apart from the obvious effect of excessive dissipation melting connections inside the device and ruining it.

Maximum power dissipation

look! electronics really mastered

... practical
... visual
... exciting!

no previous knowledge
no unnecessary theory
no "maths"



RAPY

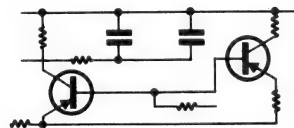
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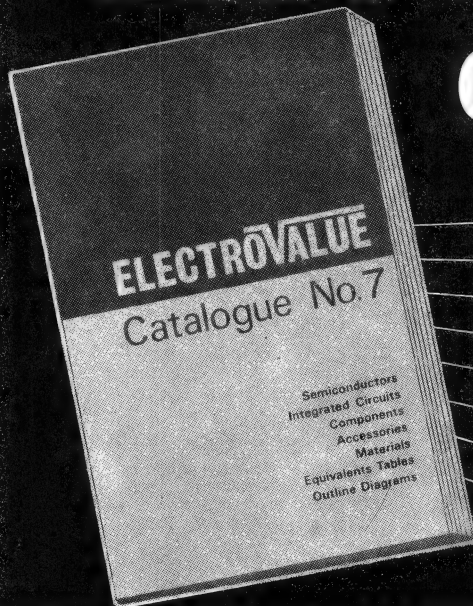
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ELECTROVALUE

CATALOGUE 7



An A to Z guide to component buying

On the index page of Catalogue 7, between "Aluminium Boxes" and "Zener Diodes" are over 200 references to contents amounting in all to thousands of items, classified, described, often priced and illustrated. There are many technical diagrams and data. At 25p, Catalogue 7 is excellent value by any standard. With the 25p Refund Voucher it costs you virtually nothing when you order £5-worth or more.

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Suitable BCD decoder driver 7447 £1.15.
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In cans, plastic sleeved
1000mF/25V 28p 1000/50 41p 5000/100 £2.91
5000mF/25V 62p 2000/50 57p
5000/50 £1.18

POLYESTER CAPACITORS TYPE C.280
Radial leads for P.C.B. mounting. Working voltage 250V d.c.

0-01, 0-015, 0-022, 0-033, 0-047 ea. 3p
0-068, 0-1, 0-15 ea. 4p
0-22 5p; 0-33 7p; 0-47 8p; 0-68 11p; 1-0 14p; 1-5 21p;
2-2 24p.

SILVERED MICA CAPACITORS
Working voltage 500V d.c.
Values in pF—2.2 to 820 in 32 stages, each 6p.
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4700, 5000 15p; 6800 20p; 8200, 10,000 25p.

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4-7	—	—	11p	—	8p	8p	8p	—
10	—	—	—	8p	8p	8p	8p	—
22	—	—	8p	8p	8p	8p	10p	—
47	8p	—	8p	8p	8p	10p	13p	—
100	9p	8p	8p	8p	8p	10p	12p	19p
220	8p	8p	8p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
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C	1/3	4-7-470K	1-3	1-1	0-9 nett
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C	1	4-7-10M	3-2	2-5	1-92 nett
MO	1	10-1M	4	3-3	2-3 nett
WW	1	0-22-3-9	9	8	8
WW	3	1-10K	7	7	8
WW	7	1-10K	8	8	8

Codes: C—carbon film, high stability, low noise. MO—metal oxide, Electrofil TR5, ultra low noise.

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(P_{tot}) has to be specified for a certain temperature differential between the device and its surroundings and whether or not the transistor is on a heat sink. Some not so obvious parameters are that the h_{fe} of a transistor varies depending on the level of collector current: a high collector current causes noise generation inside the device (when amplified it sounds like background hiss) and this is undesirable in the front stages of hi fi amplifiers—some transistors are specially selected to have low noise.

The diode capacities of reverse biased junctions in the transistor can influence high frequency circuits and must be allowed for in circuit calculations as must any internal resistance the transistor might have.

Transistors are designed, manufactured and selected to meet permutations on all these parameters (plus a few more) so you can see why there is such a vast number of different types—apart from obvious differences like silicon/germanium, or *pnp/npn*.

Wire Size

When winding coils (e.g. aerial rods or suppression inductors) I can see it is desirable to keep to the right number of turns—this, presumably, sets the inductance—but is the wire thickness important because you usually specify an s.w.g. number?

There are some instances where wire thickness is not important but as a general rule we suggest

you stick to recommendations. The coil might be carrying high current (suppressors) and unless the wire is heavy enough it might overheat. In the case of aerial rods, the length of the coil around the rod might be an important factor in setting the inductance (as might be the spacing between turns); changing the wire gauge might affect these.

At high frequencies (short waves) one should always use thicker wire because the a.c. currents only flow along the outer edges of the conductor (skin effect) and to avoid excessive internal d.c. resistance (which reduces the efficiency or "Q" of a tuned circuit) you need as large an outer circumference as possible. Sometimes multistrand (Litz) wire might be specified for the same reason. When winding bobbins for high value inductors it may not be possible to get sufficient turns on if you use a heavier gauge.

Microphony

I have quite a good quality amplifier with a microphone input. If I connect a crystal microphone to this input (which is supposed to be matched for a high impedance input) I get very good reproduction but when I kick the microphone cable I get a "clunking" noise in the loudspeaker. This is not due to pick up in the microphone as I have done this with a very long extension cable—it even happens with no microphone connected to the end! I am using coaxial cable

so I cannot see what can possibly be causing the trouble which, while not disastrous, is a bit of a nuisance.

This effect is quite common—particularly with high input impedance amplifiers fed from a predominately capacitive source (such as a crystal microphone). The cause is the capacitance between the central core and the screening of the cable you are using. When you kick the cable, or bend it quickly, you can change the spacing between the core and the screen by a small amount (due to the deformation of the insulating sleeve between them). This change in spacing gives a rise to a very small change in the cable's capacitance.

If there is any standing potential on the core a minute current will flow into, or out of this localised change in capacity. This current is amplified by your system and gives rise to the "clunk" you can hear. We say the cable is *microphonic*. There are two solutions. The first is to ensure that the cable contains twin conductors one of which is connected to the outer screening at both ends.

A more expensive way—which will give you better results with a crystal microphone—is to make a microphone pre-amplifier that will reduce the output impedance of the microphone. This should be connected into the circuit as close to the microphone as possible—you can then use much longer cables without affecting the low frequency response and use the low impedance input of your main amplifier.



DOWN TO EARTH

By GEORGE HYLTON

"Is there any simple way of telling how impedance varies with frequency?"

No, there isn't. There seems to be a lot of confusion about the meaning of "impedance". Some people seem to think that impedance must imply a circuit with capacitance or inductance in it—it ain't necessarily so.

A square is a rectangle but all rectangles aren't square. A circuit which offers impedance *may* contain capacitance or inductance, but it *could* contain just resistance, and nothing else.

IMPEDANCE

Impedance is a *general* term, which includes resistance, inductive reactance, capacitive reactance, or any combination of these. Impedance, in a.c. circuits, is like resistance in d.c. ones. It describes the ability of a circuit to impede the flow of current, irrespective of what is doing the impeding.

A 100 ohm resistor has an impedance of 100 ohms. In this case, the impedance doesn't vary with frequency. But a 1 μ F capacitor has an impedance which decreases as the frequency increases, while a 1 henry inductor has an impedance which increases with frequency. But place this inductor and capacitor in series and you find that the impedance of the combination varies with frequency in an unexpected way.

At low frequencies it's high. At high frequencies it's high. But at about 160Hz it is very low. Place the same two components in parallel, and the combined impedance is low at all frequencies except near 160Hz, when it becomes very high. Impedance can be very puzzling.

REACTANCE

What some people mean by "impedance" is the special kind which should be called reactance,

that is, the impedance of a capacitor or an inductor. These impedances vary with frequency, and although measured in ohms are really rather special quantities. They have a sort of polarity; if you think of inductive reactance as positive then capacitive reactance is negative. This explains the strange behaviour of the series and parallel LC circuits.

SERIES AND PARALLEL

The starting point for this understanding is a knowledge of the net resistance of two resistances in series and parallel:

Series combination $R = R_1 + R_2$

Parallel combination $R = R_1 R_2 / (R_1 + R_2)$

The rules for two impedances Z_1 and Z_2 are the same:

Series combination $= Z_1 + Z_2$

Parallel combination $= Z_1 Z_2 / (Z_1 + Z_2)$

On the face of things, this doesn't seem to cast any light on LC circuits and their resonant frequencies. But that's because we haven't put the signs in. If Z_1 is an inductive reactance, and Z_2 a capacitive reactance, then to allow for the "polarity" if we put Z_1 for inductive reactance we must put $-Z_2$ for capacitive reactance.

Thus the series LC circuit has an impedance of $Z_1 - Z_2$, and it's obvious that if Z_1 and Z_2 each have the same number of ohms, as they must have at one special frequency, then the combination has an impedance of zero.

The parallel combination becomes a fraction with $-Z_1 Z_2$ at the top and $Z_1 - Z_2$ at the bottom, and if $Z_1 - Z_2 = 0$ the combination is something divided by

zero. As any mathematician will tell you, the result of dividing any number by zero is an infinitely large number. Hence the very high impedance of the parallel LC circuit at its resonant frequency.

OPERATOR "j"

There's just one snag. The simple "positive inductive, negative capacitive" approach gives the parallel-resonant LC circuit a *negative* impedance. Measurement shows that this is not so. At resonance, the impedance is just a high *resistance*. So the simple "positive-negative" approach isn't the whole story. In order to make the maths correspond with reality, mathematicians play a trick. They call the inductive reactance jZ_1 and the capacitive reactance $-jZ_2$.

The series LC circuit is now $jZ_1 - jZ_2 = j(Z_1 - Z_2)$ which is zero, as before, when $Z_1 = Z_2$, since $j \times 0 = 0$. The parallel LC circuit becomes:

$$\frac{(jZ_1) \times (-jZ_2)}{jZ_1 - jZ_2} = \frac{-j^2 Z_1 Z_2}{j(Z_1 - Z_2)}$$

and when $Z_1 = Z_2$, this becomes $-j^2 Z_1 Z_2 / 0$, which is infinity times $-j^2$. Now comes the clever bit. Let $-j^2 = 1$. So infinity times $-j^2$ becomes infinity times 1, or just plain infinity.

That embarrassing negative sign has disappeared. The "j" is called an "operator", which is a mathematical name for something you invent to make it possible to get your sums right, and which obligingly disappears from the scene when you've finished.



"He constructed a device, fixed it to the lock and opened the door—I knew we shouldn't have let him subscribe to EVERYDAY ELECTRONICS!"

Everyday Electronics, May 1974

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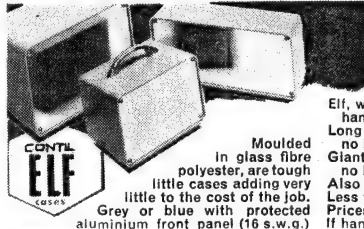
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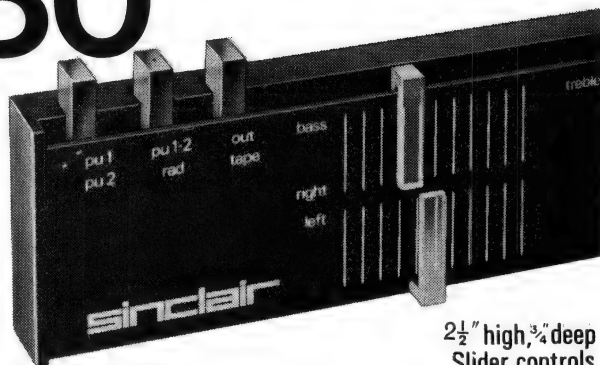
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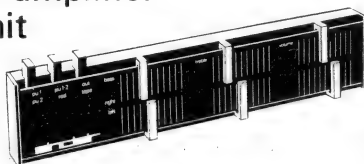
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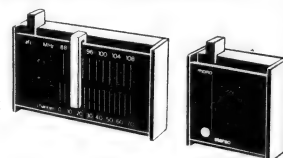
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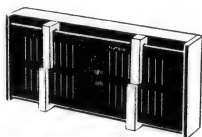


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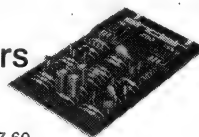
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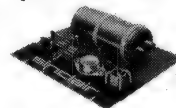
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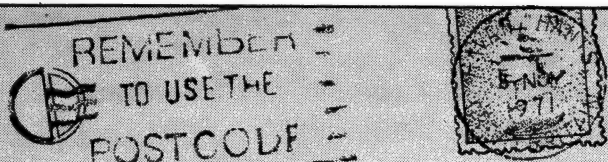
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BLOCK LETTERS

MAY. 74



Readers Letters

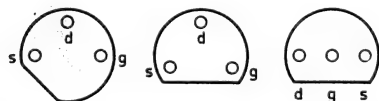
F.E.T. Connections

With reference to your January '74 EVERYDAY ELECTRONICS *Fetset* I must point out that I have just spent two hours trying to sort out why the diagram given for the field effect transistor differs from the actual component I received.

As a beginner in this field perhaps you may be able to help me know the difference between the three connections of any transistor. I hope you can find time to explain.

J. Waterhouse,
Lancs.

Various transistors have different leadout configurations and the only way to find these is to consult the published data. Some transistors are made with more than one leadout configuration and usually a suffix letter is added to the number to denote the different construction. Three different connections for the f.e.t. are shown below.



Malaysian Praise

I have been a regular reader of your fabulous magazine since I started reading it in January '73. I must say that it is both instructive and educational.

My enthusiasm in electronics grew with the regular reading of your magazine and I am sure many of my fellow Malaysian readers are finding your mag. just as interesting.

I have built some of your projects e.g. the *General Purpose Amplifier*, *Egg Timer*, *Waa Waa* unit etc, and they all worked wonderfully. My compliments to you and your staff!

Poon Chee Seng,
Malaysia

Reactance

I am a regular reader of EVERYDAY ELECTRONICS. There has been a slight error in the print of your April issue.

It is in the article *Demo Circuits* by Mike Hughes. The equation for inductive reactance is $X_L = 2\pi fL$ and that of capacitive

reactance is $X_C = \frac{1}{2\pi fC}$ but instead

you had the equation for capacitive reactance below inductive re-

actance and that for inductive reactance below capacitive reactance.

This, I think is a bit misleading for beginners, as your magazine is primarily intended for beginners in electronics.

To conclude I would like to say that it is one of the most interesting informative magazines that I have come across. I appreciate the wonderful service and knowledge we derive from it.

Y. Bayat,
London.

Somehow the two equations have been transposed. The equations are correct but appear under the wrong headings. We are sorry about this.

Electronics Club

I thought I would write and tell you about our school electronics club. I am in the third year at Kirkcaldy High School.

In the senior school there is an electronics club which meets every Monday, Tuesday and Thursday. The club supply us with resistors, capacitors, solder, soldering irons, p.c. board etc., for our projects. We have to pay for some components such as semiconductors, transformers and IC's which the club has not got in stock.

We read your magazine and enjoy building the projects you print, so we hope you will keep us supplied.

G. Wilson,
Fife.

We will certainly keep the supply of constructional projects flowing—there are four in this issue.

What do you know?

CAPACITORS

1. Calculate the total value of the following capacitors wired in series:—0.1 μ F, 0.02 μ F and 0.47 μ F.
2. Calculate the total value of the following capacitors wired in parallel:—0.001 μ F, 0.05 μ F and 0.0047 μ F.
3. You have a "flat" type capacitor with coloured bands around it. The colours are brown, black, orange, black, red, this is reading from the top (away from the leads) to bottom. State the value of the capacitor, its tolerance and voltage.
4. Is it necessary to always use an exact value electrolytic e.g. if 8 μ F is quoted could a 10 μ F normally be used and if so why?

ANSWERS

1. $\frac{1}{\frac{1}{0.1} + \frac{1}{0.02} + \frac{1}{0.47}} \mu F$
2. $C_1 = \frac{62.13}{1} = 0.016 \mu F$
3. The value is 10,000pF $\pm 20\%$ at 250V.
4. Most electrolytic capacitors have a tolerance of -20% +100%. Therefore the circuit must be able to cope with a large range of values and it is normally permissible to use a capacitor of slightly higher value.

The largest selection

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CH3. 7.5mH 25p CH4. 10mH 25p
CH5. 1.5mH 25p

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DRX1 Crystal set 31p DRR2 Dual range 45p

COIL FORMERS & CORES

NORMAN 1" Cores & Formers 7p
1" Cores & Formers 8p

SWITCHES

DP/DT Toggle 25p SP/ST Toggle 18p

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1½" and 20mm, 100mA, 200mA, 250mA, 500mA, 1A, 1.5A, 2A
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8 ohms 3.5mm plug 22p

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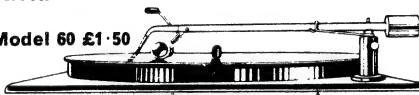
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Ref. 34. Cassette Case £1.27
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Model G. 18 watt £2.15
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STANDS: ST1 £1.21. ST2 77p
SOLDER: 18SWG Multicore 7oz 82p
22SWG 7oz 82p. 18SWG 22ft 28p
22SWG Tube 22p

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Bits No.
102 For model CCN240 3/32" 38p
104 For model CCN240 3/16" 38p
1100 For model CCN240 3/32" 38p
1101 For model CCN240 3/8" 38p
1102 For model CCN240 1/4" 38p
1020 For model G240 3/32" 38p
1021 For model G240 1/8" 38p
1022 For model G240 3/16" 38p
50 For model X25 3/32" 38p
51 For model X25 1/8" 38p
52 For model X25 3/16" 38p

ELEMENTS

ECN 240 £1.16 ECCN 240 £1.32
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C1	250	Resistors mixed values approx. count by weight	0.55
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C4	75	1/4 W Resistors mixed preferred values	0.55
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C6	2	Tuning Gangs, MW/LW VHF	0.55
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C8	10	Reed Switches	0.55
C9	3	Micro Switches	0.55
C10	15	Assorted Pots & Pre-Sets	0.55
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C13	20	Electrolytics Trans. types	0.55
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C15	4	Mains Slide Switches	0.55
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SOCKETS
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PS 36 DIN 3 Pin 0.10
PS 37 DIN 5 Pin 180° 0.10
PS 38 DIN 5 Pin 240° 0.10
PS 39 Jack 2.5mm Switched 0.09
PS 40 Jack 3.5mm Switched 0.10
PS 41 Jack 1/4" Switched 0.17
PS 42 Jack Stereo Switched 0.26
PS 43 Phono Single 0.06
PS 44 Phono Double 0.10
PS 45 Car Aerial 0.09
PS 46 Co-Axial Surface 0.09
PS 47 Co-Axial Flush 0.14

INLINE SOCKETS

PS 21 D.I.N. 2 Pin (Speaker) 0.13
PS 22 D.I.N. 3 Pin 0.17
PS 23 D.I.N. 5 Pin 180° 0.17
PS 24 D.I.N. 5 Pin 240° 0.17
PS 25 Jack 2.5mm Plastic 0.10
PS 26 Jack 3.5mm Plastic 0.12
PS 27 Jack 1/4" Plastic 0.24
PS 28 Jack 1/4" Screened 0.28
PS 29 Jack Stereo Plastic 0.22
PS 30 Jack Stereo Screened 0.32
PS 31 Phono Screened 0.14
PS 32 Car Aerial 0.15
PS 33 Co-Axial 0.17

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PS 1 D.I.N. 2 Pin (Speaker) 0.11
PS 2 D.I.N. 3 Pin 0.12
PS 3 D.I.N. 4 Pin 0.15
PS 4 D.I.N. 5 Pin 180° 0.14
PS 5 D.I.N. 5 Pin 240° 0.15
PS 6 D.I.N. 6 Pin 0.15
PS 7 S.I.N. 7 Pin 0.15
PS 8 Jack 2.5mm Screened 0.10
PS 9 Jack 3.5mm Plastic 0.09
PS 10 Jack 3.5mm Screened 0.12
PS 11 Jack 1/4" Plastic 0.13
PS 12 Jack 1/4" Screened 0.18
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PS 14 Phono 0.06
PS 15 Car Aerial 0.15
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CP 7 Three Core Mains Cable 0.07
CP 8 Twin Oval Mains Cable 0.06
CP 9 Speaker Cable 0.04
CP 10 Low Loss Co-Axial 0.10

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MT50/1	1	£1.93	30p
MT50/1	1	£2.42	35p
MT50/2	2	£3.30	40p

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ACOS GP91-18C. 200mV at 1.2cms/sec £1.18
ACOS GP93-1. 280mV at 1cm/sec £1.65
ACOS GP96-1. 100mV at 1cm/sec £2.65
TTC J-2005. Crystal/Hi Output 95p
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TTC J-200 CS Stereo/Hi Output £1.60
TTC J-2105 Ceramic/Med. Output £1.64

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The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—

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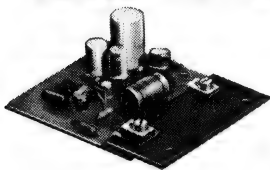
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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f=1KHz	0.25%
LOAD IMPEDANCE	—	8-16 Ω
INPUT IMPEDANCE	f=1KHz	100 k Ω
FREQUENCY RESPONSE @ 3dB	Po=2 WATTS	50 Hz-25KHz
SENSITIVITY for RATED O/P	Vs=26V. Ri=8 Ω f=1KHz	75mV. RMS
DIMENSIONS	—	3" x 2 1/4" x 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (Ri = 8 Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts	RMS	£2.19
AL 20. 5 watts	RMS	£2.59
AL 30. 10 watts	RMS	£3.01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20)	85p
SPM 80. (Use with also AL30 & AL50)	£3.25

FRONT PANELS SP 12 with Knobs	£1.10
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PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4.85
PA 100. (Use with AL30 & AL50)	£13.15

TRANSFORMERS

T461 (Use with AL10) £1.38 P & P 15p
T538 (Use with AL20) £1.98 P & P 15p
BMT80 (Use with AL30 & AL50) £2.15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 35mm.

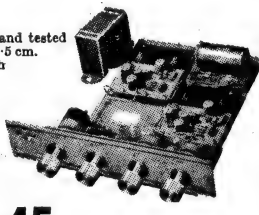
Frequency response—
20Hz-50KHz (-3dB)
Bass control—
± 12dB at 60Hz
Treble control—
± 14dB at 14KHz
*Input 1. Impedance
1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance
30 K ohms
Sensitivity 4mV

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The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25KHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion: Bass control ± 12dB at 60Hz typically 0.25% at 1 watt. Treble con. ± 14dB at 14kHz.



£14.45

NOW WE GIVE YOU 50w PEAK (25w R.M.S.) PLUS THERMAL PROTECTION! The NEW AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95



- Max Heat Sink temp. 90°C.
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- Supply voltage 10-35 volts
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm x 105mm x 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.E. enthusiast.



STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm x 105mm x 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address Intercom Units, etc. Handbook available 10p PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market. The PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages. Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response 20Hz-20KHz ± 1dB
Harmonic Distortion better than 0.1%
Inputs: 1. Tape Head 1-25 mV into 50K Ω
2. Radio, Tuner 35 mV into 50K Ω
3. Magnetic P.U. 1-5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.
Bass Control ± 15dB at 20Hz
Treble Control ± 15dB at 20 KHz
Filters: Rumble (High Pass) 100Hz
Scratch (Low Pass) 8KHz
Signal/Noise Ratio better than -65dB
Input overload + 26dB
Supply + 35 volts at 20mA
Dimensions 292mm x 82mm x 35mm

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Centred around a simple constructed "audio modulator" unit, the P.E. Sound Bender is not just a single sound effects unit, but your key to a host of exciting with-it sounds.

Just feed a music or speech signal to one input and a control signal to the other and you can have a tremolo, a frequency doubler, a ring modulator, or a voice-operated fader.

Also in the MAY ISSUE...

FIRST STEPS IN CIRCUIT DESIGN - 2

The second article in this new series for beginners deals with the "parameter jungle", input impedance and voltage gain equations.

PLUS

An Improved BATTERY CHARGER

This "fail-safe" design includes short-circuit, reverse-polarity, and overcharge protection - without adding drastically to the costs.

ELECTRONIC FLASH METER

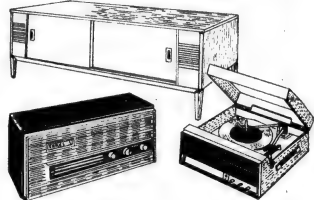
Remove the chance element from flash photography with an accurate and simple-to-operate instrument which will cope with all normal and many abnormal exposure conditions for both black-and-white and colour photography.

PRACTICAL ELECTRONICS

MAY ISSUE ON SALE MID APRIL* 25p

* subject to the current national industrial situation at the time of going to press

The items below are from the March Supplement to our 1974 Catalogue. You can receive this Catalogue and the next 12 supplements by sending 66p.



Stereo Radiogram Cabinet. Long, Low and Modern. Front veneered with sliding front and tapered legs. Speaker spaces each one 5" size approx. 11" x 15" x 18". Probably cost over £20 to make. Our Price £8.10 each. We can arrange delivery within 200 miles if you can order 10 or more.

Bush Record Player. Bush Ref. No. SRP 64. Separate bass and treble controls help give this unusually good sound quality. A suitable amplifier-speaker unit converts this to full stereo. Cabinet size 7 1/2" x 16 1/2" x 18". Finished in charcoal grey leather cloth. Fully transistorised with 8" x 5" speaker. Controls bass, on/off, treble and volume. Socket stereo. Makers recommended price £27.75. Our Price £17.72. A saving of over £8. Post and insurance £2.

Erres Table Radio. Dutch made. Three waveband (L.M. & S.). Nice size (16 1/2" x 8 1/2" x 5") wooden cabinet with high gloss finish. 6" x 4" speaker gives better than average tone—these radios are very well made from good quality components and should not be confused with Hong Kong makes. They recently retailed at £18 each and were well worth it. The ones we have are brand new and working but have failed final inspection because either they will work only on mains or only on batteries. It is unlikely that the fault is very much however and we are arranging for a circuit diagram. Price £8.64 plus £1 post and insurance.

Electric Welder. Big transformer in metal case with carrying handle and control switch, output through very heavy duty terminals. Output volts 1.9-4.25 volts max. 117 amps.—normal mains input socket for optional foot switch. £19.50 plus £2 carriage up to 200 miles. A further £1 for each 100 miles extra.

24v 3 amp Mains Transformer. Upright mounting with fixing clamps, standard primary 240/200/195/160—£3.50 plus 30p post and service.

Mains Transformer. (6.5v-0-6.5v at 500 mA and 1v at 1 amp). Normal tapped primary. Upright mounting with fixing lugs. £1.00.

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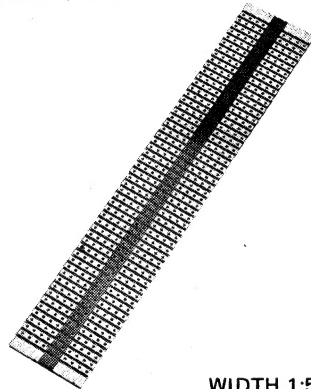
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AD162 36p	BC158 14p	BFY51 20p	2N3055 60p	40408 40p
AFI14 20p	BC159 14p	BFY52 20p	2N3702 12p	ZTX108 15p
AFI15 20p	BC187 22p	BU105 235p	2N3703 12p	ZTX300 15p
AFI16 20p	BD131 75p	OC26 45p	2N3704 13p	ZTX302 20p
AFI17 20p	BD132 75p	OC28 50p	2N3705 12p	ZTX500 15p
AFI18 38p	BD133 75p	OC35 50p	2N3706 11p	ZXT503 20p

ZENER DIODES

400mW 5% 3.3V to 30V, 12p.

WIRE WOUND POTS. 3W, 10, 25,

50 Ω and decades to 100k Ω, 5p.

DIODES

RECTIFIER	Signal
BY127 1250V 1A 12p	OA85 7p
IN4001 50V 1A 7p	OA90 5p
IN4002 100V 1A 8p	OA91 5p
IN4004 400V 1A 8p	OA202 7p
IN4006 800V 1A 10p	IN4148 8p
IN4007 1000V 1A 10p	BA114 8p

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.

DUAL GANG, 10K + 10K etc. log. or lin. 60p.

KNOB FOR ABOVE, 12p.

FRONT PANEL, 65p.

18 Gauge panel 12in x 4in with slots cut for use
with slider pots. Grey or matt black finish com-
plete with fixings for 4 pots.

BRUSHED

ALUMINIUM

PANELS

12in x 6in, 25p

12in x 24in, 10p

9in x 2in, 7p

THYRISTORS

2N5060 50V 0.8A 65p

2N5064 200V 0.8A 80p

106F 50V 4A 55p

106D 400V 4A 80p

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0.001μF, 0.0015μF, 0.0022μF, 0.0033μF, 0.0047μF, 23p, 0.0068μF, 0.01μF,
0.015μF, 0.022μF, 0.033μF, 3p, 0.047μF, 0.068μF, 0.1μF, 4p, 0.15μF, 6p, 0.22μF,
7p, 0.33μF, 11p, 0.47μF, 13p.
160V: 0.01μF, 0.015μF, 0.022μF, 0.033μF, 0.047μF, 0.068μF, 3p, 0.1μF, 3p, 0.15μF,
4p, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 7p, 0.68μF, 11p, 1.0μF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p, 0.033μF, 0.047μF, 0.068μF,
3p, 0.1μF, 4p, 0.15μF, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 8p, 0.68μF, 11p, 1.0μF,
13p, 1.5μF, 20p, 2.2μF, 24p.

MYLAR FILM CAPACITORS 100V

0.001μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF,
2p, 0.04μF, 0.05μF, 0.068μF, 0.1μF, 3p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS

(μF/v) 1/63, 1.5/63, 2.2/63, 3.3/63, 4.7/63, 6.8/40, 6.8/63, 10/25, 10/63, 15/16, 15/40,
15/63, 22/10, 22/25, 22/63, 33/6.3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6.3,
68/16, 100/4, 100/10, 100/25, 150/6.3, 150/16, 220/4, 220/6.3, 220/16, 330/4, 6p, 47/63,
100/40, 150/25, 220/25, 330/10, 470/6.3, 7p, 68/63, 150/40, 220/40, 330/16, 1000/4, 10p,
470/10, 680/6.3, 11p, 100/63, 150/63, 220/63, 1000/10, 12p, 470/25, 680/16, 1500/6.3, 13p,
470/40, 680/25, 1000/16, 1500/10, 2200/6.3, 18p, 330/63, 680/40, 1000/25, 1500/16,
2200/10, 3300/6.3, 4700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS

	12p
0.1μF 35V	2.2μF 16V
0.22μF 35V	4.7μF 10V
0.47μF 35V	6.8μF 25V
1.0μF 35V	10μF 25V
	100μF 3V

VEROBOARD

	0.1	0.15
2 1/2 x 3 1/2	22p	16p
3 1/2 x 5	24p	24p
3 1/2 x 5 1/2	24p	24p
3 1/2 x 5	27p	27p
17 x 2 1/2	75p	57 1/2p
17 x 3 1/2	100p	78p
17 x 5 (plain)	—	82p
17 x 3 1/2 (plain)	—	60p
17 x 2 1/2 (plain)	—	42p
2 1/2 x 5 (plain)	—	12p
2 1/2 x 3 1/2 (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	28p	2.5mm insulated	12p
Standard insulated	18p	3.5mm insulated	12p
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97p
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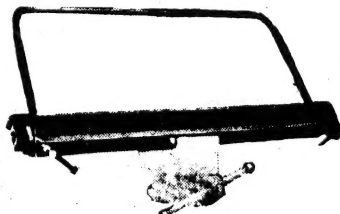
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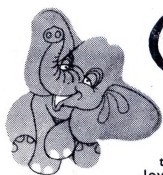
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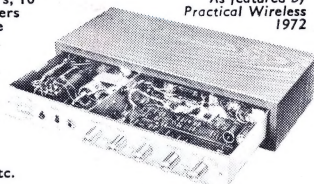
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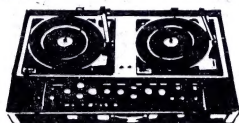


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